

Disassembly and Inspection

4

Introduction

This chapter will address disassembly of the entire engine, from the fuel injection system down to the block. We'll begin by removing all the "extraneous" hardware, then we'll tear down the engine itself. Because disassembly offers unique opportunities for locating certain types of problems with specific components or assemblies, I'll discuss component troubleshooting where it's pertinent.

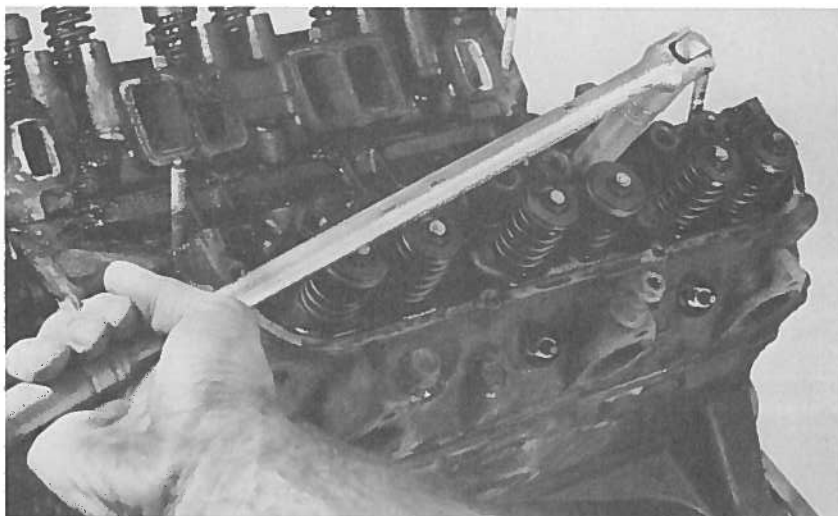
The best way to tear an engine down is with hand tools, not power tools, because your hands can tell you when one bolt is looser than the rest and by approximately how much. This is invaluable to finding the cause of many problems.

As you disassemble the engine, have a pencil and a notepad at hand. As you encounter mechanical problems—say the head bolts between cylinders three and five are significantly looser than the others—record the information. This will remind you to check other related parts in the same area, like the head gasket, as you continue with the disassembly.

It can also serve as a "shopping list" that will save you repeated trips to the auto parts store. When you come across a sensor that's been damaged, or a bolt that's stripped or missing, write it down.

As you disassemble the engine, you'll need some way of keeping all mated components together in their original positions. These paired parts wear into each other in a specific pattern, creating a "fingerprint" of sorts. If this fingerprint is changed, the mating surfaces of the components will wear rapidly, requiring component replacement.

You can use old coffee cans, plastic bags, Tupperware, just about anything to store all the components from a particular cylinder together. Whatever system you devise, you'll need to identify which lifter was fitted to the intake lobe on the cam and which was on the exhaust. The same goes for the pushrods and valve spring hardware. If you want to be more organized in your approach, you



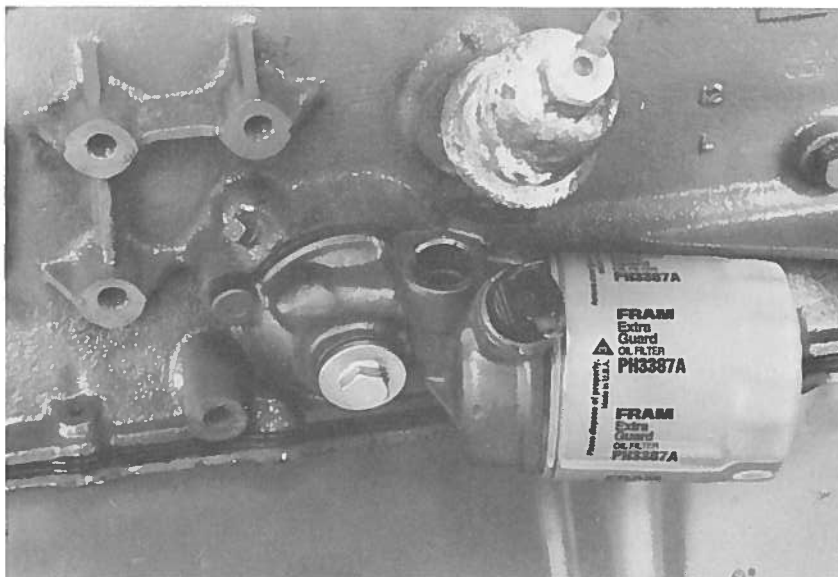
Always use hand tools to disassemble an engine. Using power tools is like using a hammer to shell a peanut: You get

the job done, but you don't know what to look for after you're finished.

can order molded trays (the Eastwood Company 1-800-345-1178 carries these) that have pockets for each of the major engine parts you'll remove from the engine.

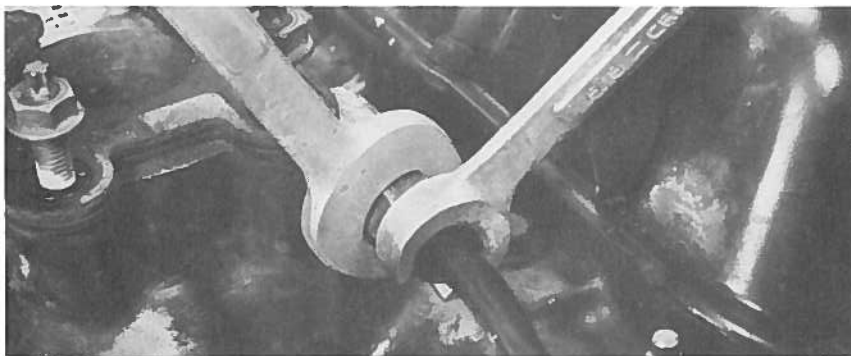
General Information

To avoid chasing parts around on the ground, remove small components from the major components while the major components are still

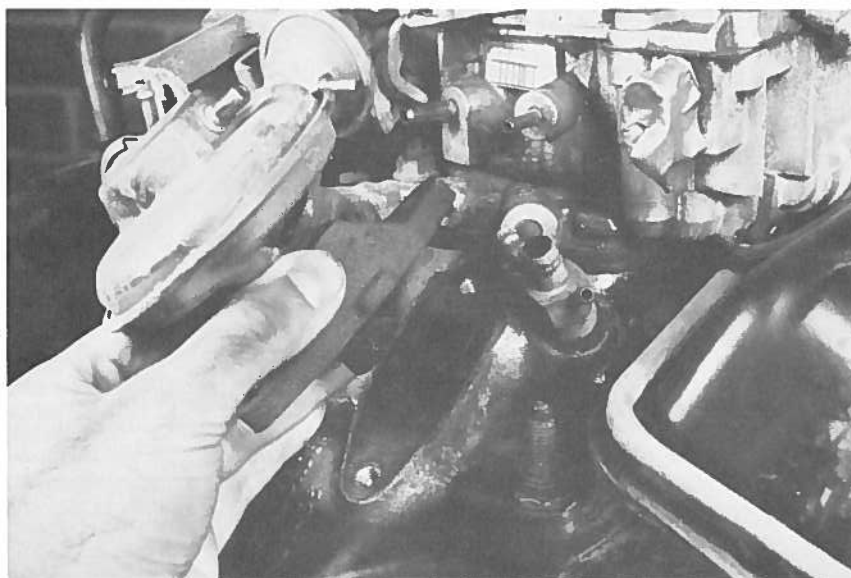


Rear-wheel-drive vehicles use a separate oil filter mount. The hollow "banjo" bolt in the center of the mount uses an

O-ring near its head for sealing. Be sure to replace it.

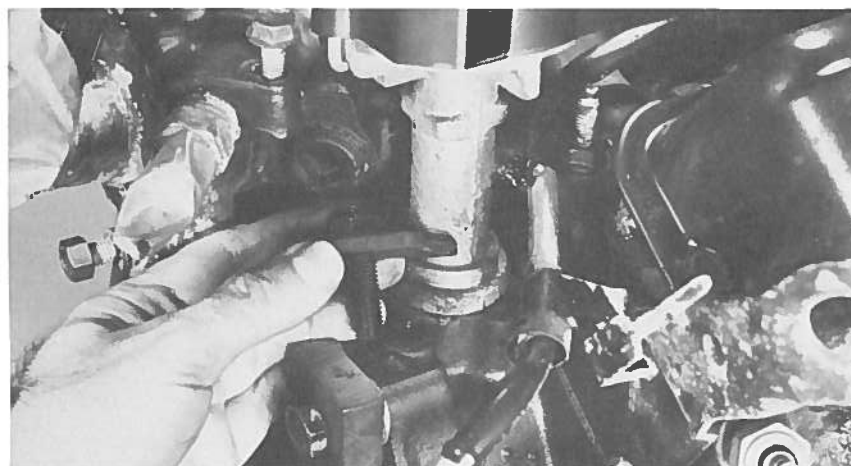


If you try loosening a fitting and the fitting it's mated to begins to turn, use the back-up wrench technique shown here.



This EGR valve is vacuum operated. An electrically operated EGR valve is

used on some later engines, beginning in the 1990 model year.



A bolt and clamp are all that's used to hold the distributor in position. This

same arrangement holds the oil pump drive in place.

attached to the engine. Also, keep bolts attached to their components and in their exact location whenever possible. This might make it somewhat cumbersome during some cleaning operations, but assembly will be quicker and more accurate.

Several bolts on the 60deg V-6 have a head that's 18mm across the flats, but most tool sets don't contain wrenches or sockets of this size. So borrow or buy these tools beforehand.

Oil Pressure Switch

Typically, the oil pressure switch is screwed into the block just above and to the left of the oil filter mount in front-wheel-drive vehicles and on the oil filter mount in rear-wheel-drive vehicles. These locations aren't ironclad, however, because on some engines the oil pressure switch is on the top of the block, just forward of the bell housing mounting flange. Wherever you find it, it can be removed with a special socket made for sending units or a pair of slip-joint or locking pliers.

Fuel Line Fittings

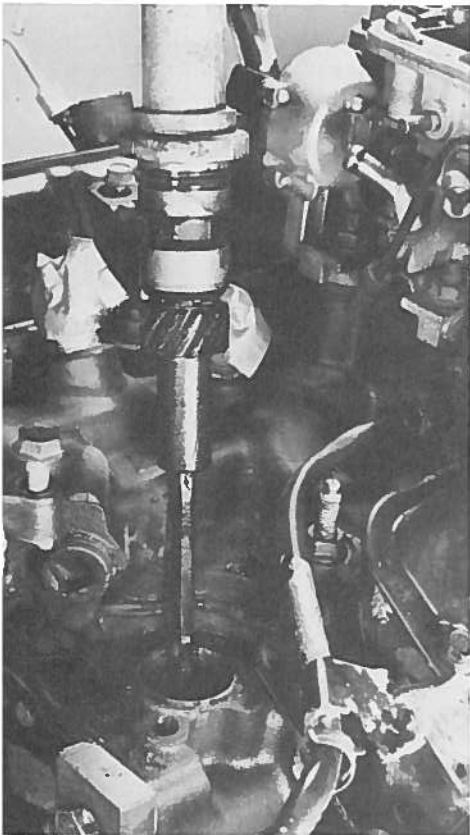
To break one fuel line fitting (and sometimes vacuum line fittings) free from the other, you will need to use a flare-nut wrench on the fitting you want to loosen and another wrench on the fitting you don't want to loosen. The second wrench "backs up" the first wrench to prevent the fitting you don't want to loosen from rotating.

Fuel Pump

To remove the fuel pump on carbureted models, loosen the nut for the fuel feed line at the carburetor and the fuel pump with a flare-nut wrench, then remove the line. Two bolts secure the fuel pump to the block. Hold onto the pump as you remove the bolts to keep it and the pushrod behind it from falling on the floor. As you pull the fuel pump away from the block, note that both a gasket and an O-ring are used to seal the pump to the block. You'll want to replace these items with new parts to ensure there is no oil leakage.

EGR Valve

Two bolts secure the EGR valve to the intake manifold. Depending upon the valve's proximity to other components, you'll need a 1/4in-drive socket or box wrench to remove the bolts.

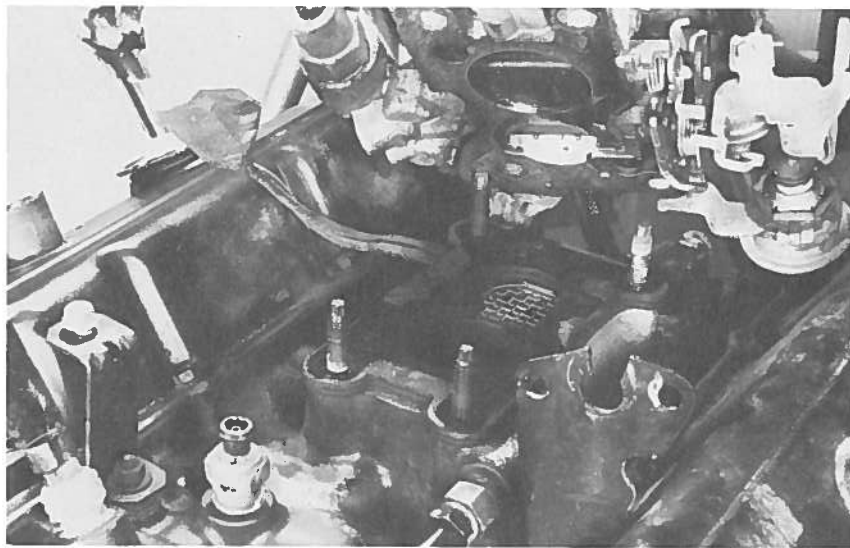


When you pull the distributor (or oil pump drive) out of the block, a long, hex-shaped shaft will come out with it. This shaft drives the oil pump with a driven gear at the bottom of the distributor (or oil pump drive) and the drive gear near the rear of the camshaft.

Distributor/Oil Pump Drive

Some engines use distributor-based ignition systems, in which case the distributor is held in the block with a clamp and bolt. Remove them, then pull the distributor straight out of the engine. If the distributor is stubborn, you may need to position a screwdriver between the base of the engine and the intake manifold and lever it up. A hex-shaped shaft about 9in long will come out with the distributor. The distributor uses this shaft to drive the oil pump.

If your engine isn't equipped with a distributor, it uses an oil pump drive, which is basically the lower half of a distributor. Its job is to connect the oil pump to the drive gear at the rear of the camshaft, so that whenever the cam rotates, it drives the oil pump. The oil pump drive is held in place with a clamp and a bolt, just like the distributor. After removing the



If your car or truck engine is equipped with a carburetor, and is a 1981 or newer model, an Early Fuel Evaporation (EFE) grid is used underneath the

carburetor. Eventually, the EFE grid breaks up, causing a host of driveability problems. If yours is missing any part of the grid, replace it.

bolt and clamp, grab the top of the pump drive and pull it out of the engine. If it doesn't come out, try sliding a screwdriver underneath it and levering it out.

Sensors

Sealant is used on the threads of all the sensors that screw into the block. After enough time and exposure to engine heat, this sealant acts like an adhesive, adding to the torque required to remove a sensor. Consequently, you may need to use a 1/2in-drive deep-well socket to remove the sensors. Giving the ratchet handle a sharp rap with a hammer will also help to break the sealant bond.

Thermostat Housing Neck

Before you remove the thermostat housing neck, note its orientation as well as those of its mounting studs. An O-ring, gasket, or room-temperature vulcanizing (RTV) sealer is used to seal the thermostat housing to the inlet manifold. Remove any remaining sealant with a small putty knife. Take care not to nick the sealing surface, or you could start a path for coolant leakage. Always replace gaskets and O-rings to ensure proper sealing.

Exhaust Manifolds

Each exhaust manifold is secured to the heads with six bolts. These bolts can rust so badly that the

bolt heads actually become smaller. So always take the time to find a six-point socket that fits the head snugly to reduce your chances of rounding the bolt heads.

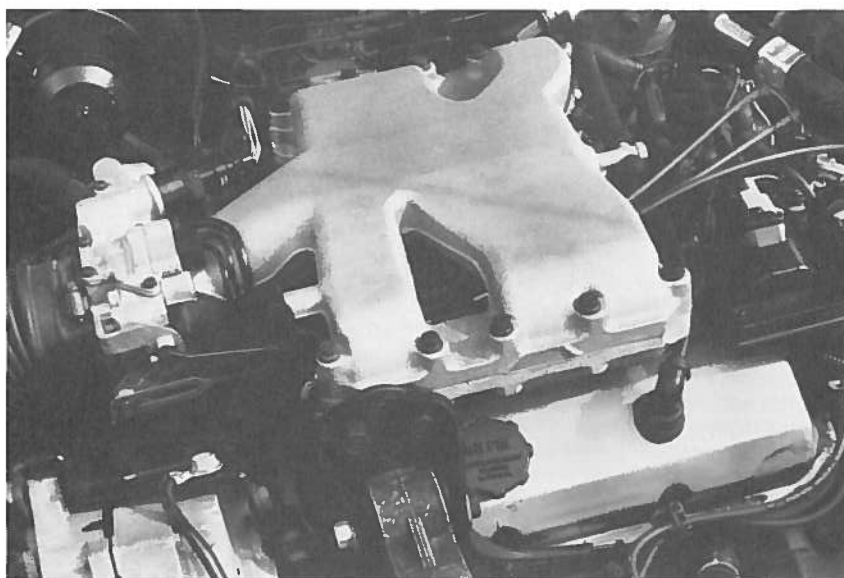
Carburetor and Throttle Body

If your engine is equipped with a Multi-Port Fuel Injection (MPFI) system, skip to that section for disassembly procedures. If your engine is equipped with a carburetor or throttle body, read on. The carburetor and throttle body are retained in the same manner: nuts screwed over four mounting studs. After removing the nuts, carefully lift the carburetor or throttle body off the studs.

EFE Grid

If your engine is fitted with a carburetor, an Early Fuel Evaporation (EFE) grid is probably used underneath it. This grid preheats the fuel as it flows from the carburetor to the inlet manifold, thereby improving driveability when the engine is cold. Unfortunately, this grid has a tendency to disintegrate and cause driveability problems.

After sliding the EFE grid off the carburetor mounting studs, carefully inspect it. The bars forming the grid should not show signs of erosion, and the grid should be intact for the entire opening in the plate. If the grid has any problems, replace it.



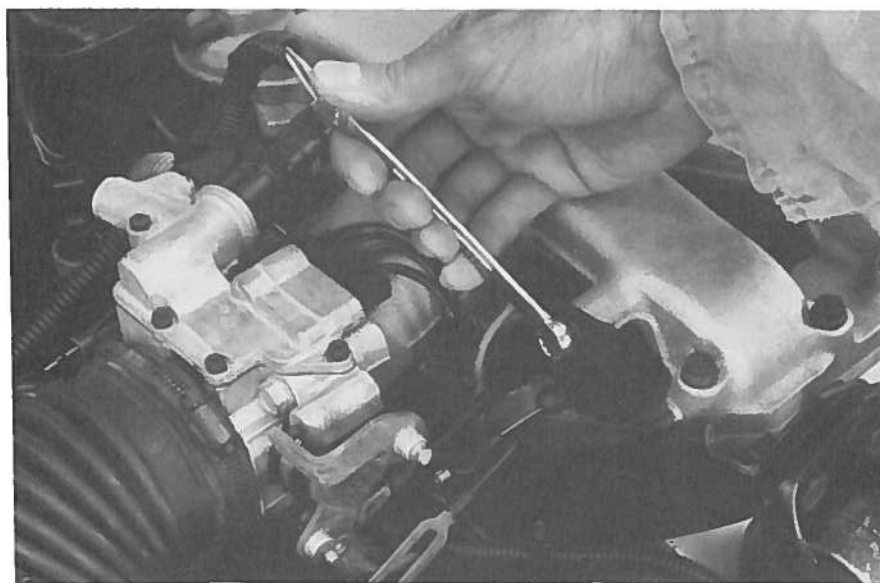
The Multi-Port Fuel Injection (MPFI) system was used on hundreds of thousands of 2.8- and 3.1-liter V-6 engines.

Multi-Port Fuel Injection System

By following the directions in this section, the Multi-Port Fuel Injection (MPFI) system may be removed with or without the engine in the car.

Begin dismantling the MPFI system by removing the cable(s) from the linkage on the throttle body. Up to

three cables can be connected to the throttle body linkage: throttle, automatic transmission downshift (TV), and cruise control. If the vehicle is equipped with an automatic transmission, the TV cable will be attached to the top of the linkage. Remove it by inserting a screwdriver between it and the linkage and popping it off. The lower cable is for the throttle, and



Up to three cables may be connected to the throttle body: throttle, cruise control, and transmission downshift. The cables fit into a bracket that's bolted to the up-

per and lower portions of the plenum. When you remove the upper plenum, you'll be able to access the bolts that secure the bracket to the lower plenum.

is retained by a safety clip. To remove the clip, pry the tang away from the shaft with a small screwdriver, get a good grip on the clip (it tends to fly), and push the clip back. Finally, pull the cable off the shaft. If the vehicle is equipped with cruise control, the cruise control cable will be positioned on the back side of the linkage. Using the same technique that you used for the throttle cable, remove its retaining clip, then slide the cable off the shaft.

Next, unbolt the bracket that supports the cables from the upper plenum. The ganged vacuum hoses from the top of the throttle body are removed by grasping the rubber manifold they're joined at, then wiggling the manifold while you pull it away from the throttle body.

All of the electrical connectors are removed in virtually the same way: pull the tab on the connector away from the component while pulling the connector out. A connector's tab may be on the top, bottom, or side. Always disengage it before trying to pull the connector free.

The convoluted tube running to the side of the throttle body is for the EGR valve. Remove it and its perforated gasket from the throttle body. Then carefully bend it back out of the way to avoid fracturing it.

The next thing to remove is the air intake hose that's connected between the Mass Air Flow (MAF) sensor and the front of the throttle body. It's held in place at both ends by a large, worm clamp. The air intake hose may also have a hose that runs to the PCV valve in the rocker cover. If this is the case, pull the PCV valve out of the rocker cover, then loosen the clamp screws and pull the hose off.

While you're near the throttle body, open the throttle with your hand. If the area just behind the throttle blades is lined with carbon, you've just found the reason for a poor idle. As the carbon builds up, the air gap between the throttle blades and the throttle body closes off, resulting in a lower-than-normal idle. Be sure to remove this carbon before installing your rebuilt engine.

Moving to the other end of the engine, you'll find a vacuum hose that runs from the top of the intake manifold to the power brake booster. Loosen its retaining clip with a pair of pliers, and remove it from the manifold.

Ten bolts secure the upper plenum to the lower plenum. Take note of any brackets that might be secured by these bolts, then remove the bolts and lift the upper plenum.

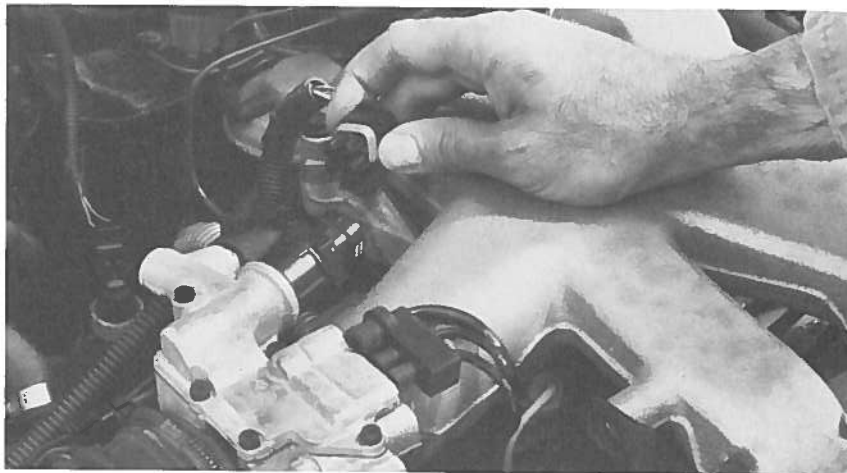
When you lift the upper plenum, you can access the coolant lines that run to the bottom of the throttle body. If these lines have never been removed, they'll be retained with crimp-type clamps. Cut the clamps with a pair of side cutters, taking care not to cut the hoses.

When the clamps are off, rotate the hoses back and forth while pulling them off the nipples on the throttle body. If a hose is corroded to the nipple, slide the tip of a small screwdriver between them. Work it around the nipple to break the corrosion bond, then remove the hoses and plenum.

After you've removed the upper plenum, tape over the openings in the lower plenum so you don't drop any hardware into the engine. With the upper plenum removed, you'll have easy access to the fuel lines, fuel rail, and injectors. Before disconnecting the fuel lines, move the cables out of the way by removing the cable-retaining bracket near the center of the plenum and then gently bending the cables to the side. You must also bleed off any residual fuel pressure in the fuel rail. To do this, take the cap off the Schrader valve located at the back of the fuel rail, near the distributor. Wrap a rag around the valve to catch any fuel that may spray out, and then depress the tip of the valve with a small screwdriver. Depressing the valve for only a second or two will relieve any pressure.

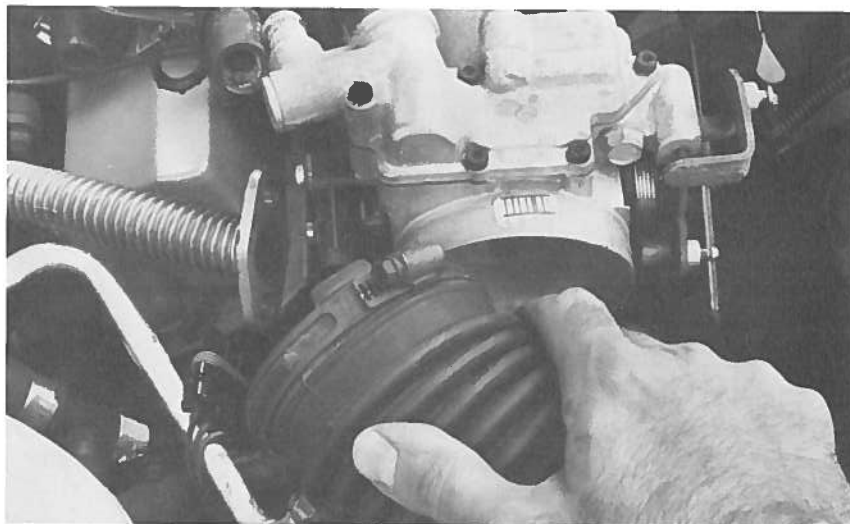
Now turn your attention to the fuel injector wiring harness. Before you disconnect the harness from the injectors, tag each of the connectors at the injectors. You can identify them by the cylinder to which they're fitted (cylinders 2, 4, and 6 are on the front or driver's side of the engine, and cylinders 1, 3, and 5 are on the rear or passenger side). Remove connectors by pushing the wire retainer near their ends in while wiggling the connectors away from the injectors. If a connector won't come off, you're probably not pushing the retainer in far enough to disengage it from the injector. Remove the two bolts that secure the injector harness to the fuel rail, and move the harness out of the way.

Now remove the vacuum line from the pressure regulator. Rotate it



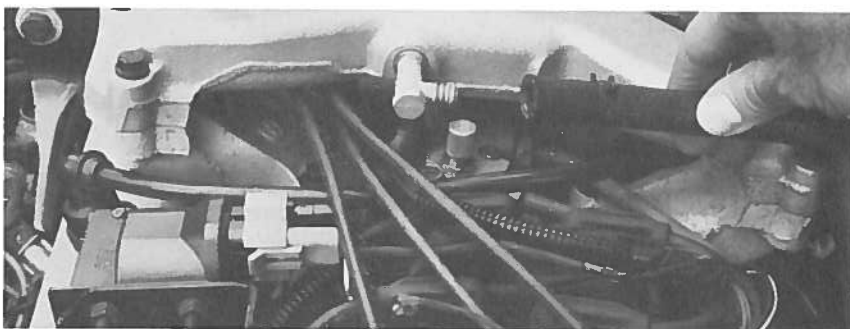
The electrical connector at the Idle Air Control (IAC) is retained by a clip. Pull the clip away from the IAC and pull the connector out. Remove the trio of vac-

uum hoses fitted into the top of the throttle body by wiggling the rubber manifold as you pull it from the throttle body.



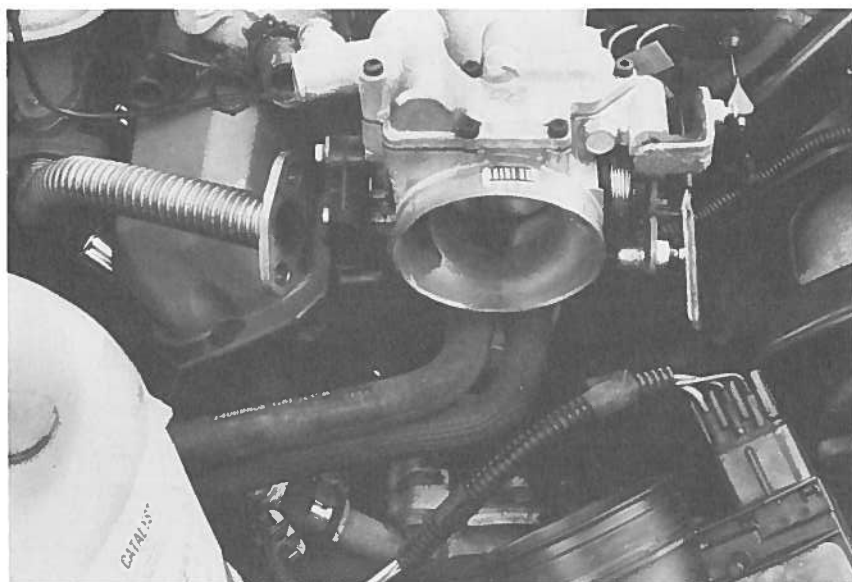
The Mass Air Flow (MAF) sensor (not used on all engines) is connected by a large-diameter pleated hose to the

throttle body. After loosening the screw on the band clamp, pull the intake hose off the front of the throttle body.



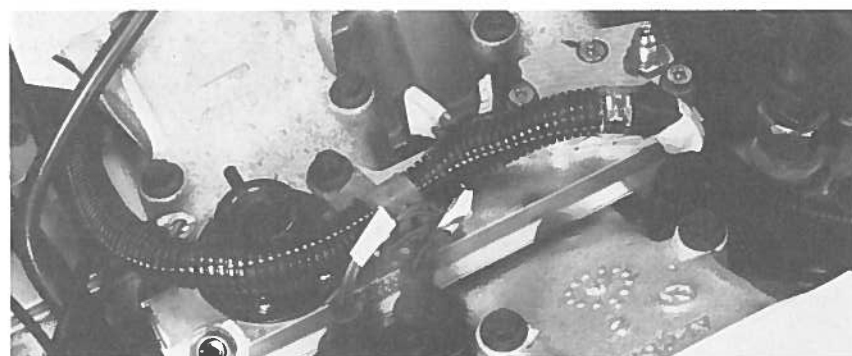
This vacuum hose runs to the power brake booster. Remove the hose from the intake manifold and plug it to pre-

vent moisture from entering the brake booster.



Coolant supply and return lines run to nipples underneath the throttle body.

This helps prevent icing of the throttle plates.



Be sure to tag the wires at each injector before removing them. This will ensure

that the injectors fire in the proper order after you put the engine back together.



Twist and pull the vacuum line from the pressure regulator.

from side to side as you pull it off.

The small line next to the regulator at the end of the fuel rail leads to the cold start fuel injector in the lower plenum. This injector works when engine coolant is below a certain temperature, much like a choke in a carbureted engine. To remove the cold start injector and its integral fuel supply line from the fuel rail, you have to disconnect the line from the fuel rail, as well as the injector from the plenum. But first, you need to disconnect the wiring harness from the injector, which can be a trying experience.

Remove the harness by placing the tip of one screwdriver underneath the wire retainer and lifting it up out of its slot on the connector while you keep it from falling back into its slot with another screwdriver. When the retainer is completely out of its slot, you can pull the connector from the injector. Now remove the bolt that holds the cold start injector and the supply line nut on the top of the fuel rail. At this point, you can pull the injector out of the manifold. If the accessory mounting brackets haven't been removed, you'll have to snake the injector out between them.

With the injector out, note the O-rings near its end and on the end of the fuel supply line where it connects to the rail. Replace both O-rings to avoid a problem with fuel leakage or cold start driveability. You can find new O-rings in a typical fuel injection overhaul gasket kit.

Now use flare-nut wrenches to remove the fuel lines. To pull the fuel lines from the fuel rail, you must first disconnect the bracket that secures the lines. This bracket is just a few inches downstream of the fittings. Now you can remove the two bolts that hold the fuel rail to the intake manifold.

When you're removing the fuel rail, keep in mind that the rail and the injectors are removed as an assembly. To accomplish this, you may need to slide a large screwdriver underneath the fuel rail and carefully pry up. Work the screwdriver in at one end and then the other until the injectors are free of the cylinder heads. Since the fuel rail will still contain fuel, hold the rail level after you remove it, then drain the fuel into a suitable container. Finally, remove the lower plenum from the intake manifold. It's retained with eight bolts.

Crankshaft Damper

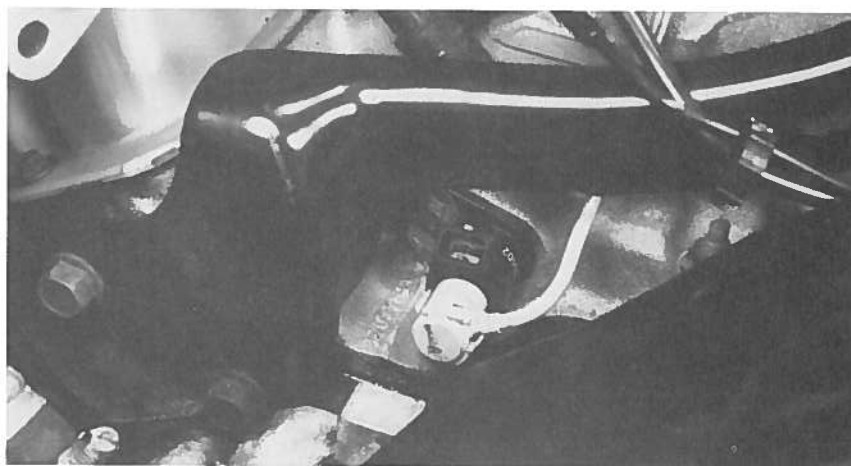
You will need a special puller to remove the crankshaft damper. This puller screws into the spokes of the damper and pushes against the front of the crankshaft to pull the damper off the crankshaft.

If you try to use a normal two- or three-jaw puller on the outside of the damper, you'll rip the rubber that secures the damper's inertia ring to the hub. This will destroy the damper's tuning and may cause the crankshaft to break as a result of uncontrolled harmonic vibration. It can even be a safety hazard, if you happen to be watching the engine run when the inertia ring slides off the hub.

Pullers are available from tool rental shops as well as auto parts or Sears stores. If you plan on rebuilding other engines, even on an infrequent basis, it probably makes more sense to buy your own puller rather than rent it.

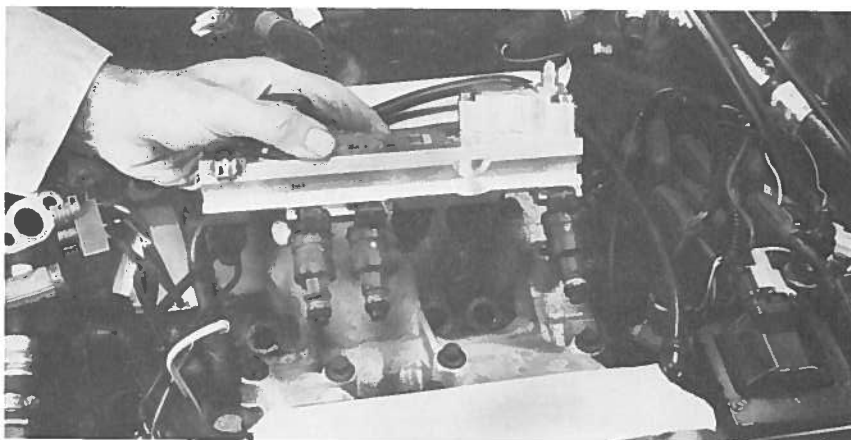
To attach the puller to the damper, you must first remove the bolt and washer from the center of the crankshaft. Lubricate the threads and tip of the puller's center screw with wheel bearing grease to prevent damaging the puller or the crankshaft. When you attach the puller to the damper, use washers under the heads of the hub screws so that they don't pull through the puller. Thread the screws into the damper hub at least four revolutions, but not more than ten, to ensure that you have enough threads to pull against. The screws should screw into the hub fairly easily. If they don't, chances are you've selected the wrong screws.

The bolts should be tightened equally so that the center screw of the puller pulls the damper straight off the crankshaft. Tighten the center screw until it is firmly seated against the front of the crankshaft, then give it a couple of good whacks with a hammer. The impact will help loosen the damper's death grip on the crank. When the center screw loosens, tighten it once again and give it another couple of whacks. Keep doing this until the damper is loose on the crankshaft. When you've loosened the damper sufficiently, hold the puller and turn the center screw in until you notice a significant decrease in the torque needed to turn the screw. At this point, you can pull the damper off the front of the crankshaft.

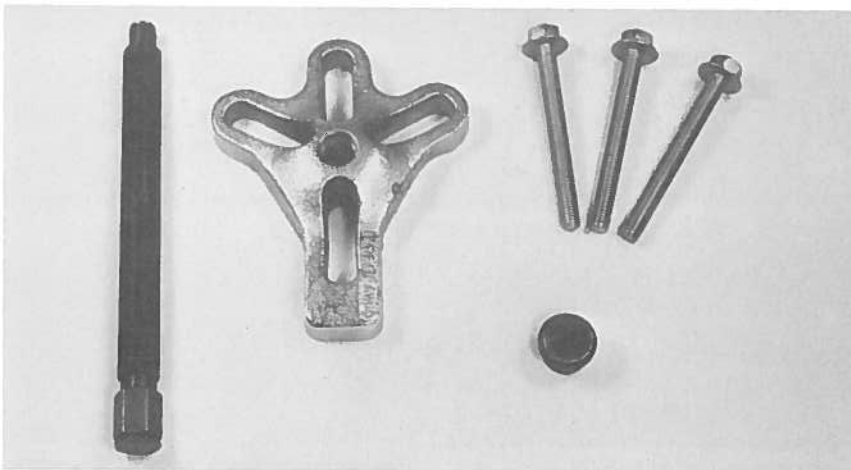


The cold start injector is positioned at the end of the intake manifold. Appropriately enough, it's found at the front of the manifold on front-wheel-drive cars

and at the rear of the manifold on rear-wheel-drive vehicles. Replace the injector and supply line O-rings before you reinstall the injector.

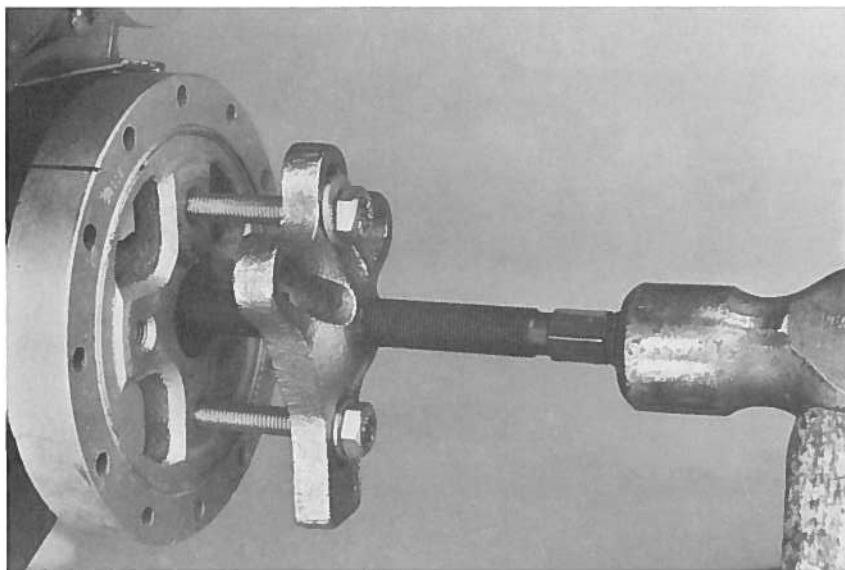


The fuel rail and injectors are removed as an assembly.



This is the only type of puller you should use to remove the damper. You should be able to rent one for about

\$10, or you can buy a good one for about \$20.



When the puller screws are tightened equally and the center screw is tightened against the nose of the crankshaft, give the center screw a good

whack with a hammer. By alternating between tightening the center screw and hitting the screw, you can "walk" the damper off the crankshaft.

Water Pump

The water pump on all engines built after 1981, except those used in Cavalier, Corsica, and other kindred chassis, is secured to the front timing chain case with eleven fasteners: ten bolts, and one nut. The nut is at the top edge of the water pump, at about

eleven o'clock, and is threaded to the end of a stud.

After loosening (but not removing) the water pump bolts and nut, you may find that you can't separate the water pump from the timing chain case. The gasket is the culprit in this case. Resolve the situation by

tapping downward on the water pump with a rawhide mallet. This should shear the gasket and release the water pump. Then remove the retaining bolts.

The water pump used on General Motors J-cars, like Cavalier, is mounted to a housing that's integral with the timing chain case. Simply remove the bolts that retain the pump and remove it.

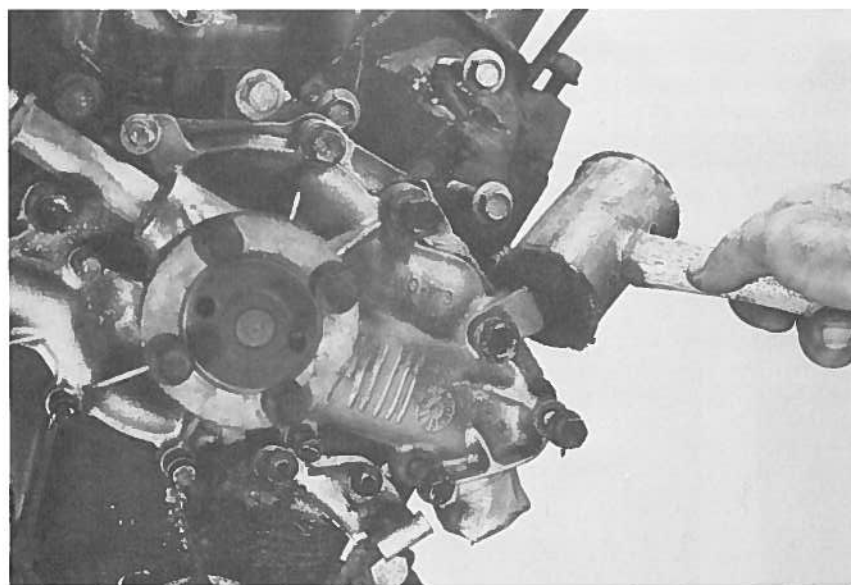
Timing Chain Case

As its name implies, the timing chain case covers the timing chain. On engines with a distributor-based ignition system, it also serves as an attachment point for the ignition timing tab. This tab is secured to the case with rivets and should not be removed.

With the water pump off, only three bolts and one stud retain the case to the front of the block. The stud is at the top of the case. Two bolts are on the lower right side of the case and one is on the lower left. Earlier engines also use two bolts to secure the front of the oil pan to the case. When all the retaining bolts are out, tap the case with a soft-faced mallet to break the gasket seal so that you can remove it from the engine.

Woodruff Keys

With the timing chain case off, you'll find one or two small block(s) of



Three different sized bolts (and one nut on 1981 and later engines) hold the water pump in position. After loosening the nut and bolts, hold the water pump with

one hand and break the seal between it and the timing chain case with a soft-faced hammer. The lug on the end of the pump is a good place to tap.



To prevent the removal of the water pump from breaking the seal between the timing chain case and the block, 1981 and later 60deg V-6 engines use this stud to secure the top of the timing chain case.

steel sticking out the side of the crankshaft. These are called woodruff keys.

Woodruff keys fit into a slot on the inside of the crankshaft gear and damper hub and positively index them to the crankshaft. Earlier engines used two separate woodruff keys: one for the damper and another for the crankshaft gear. Later engines use one long woodruff key that does double-duty by positively locating both the damper and the crank gear.

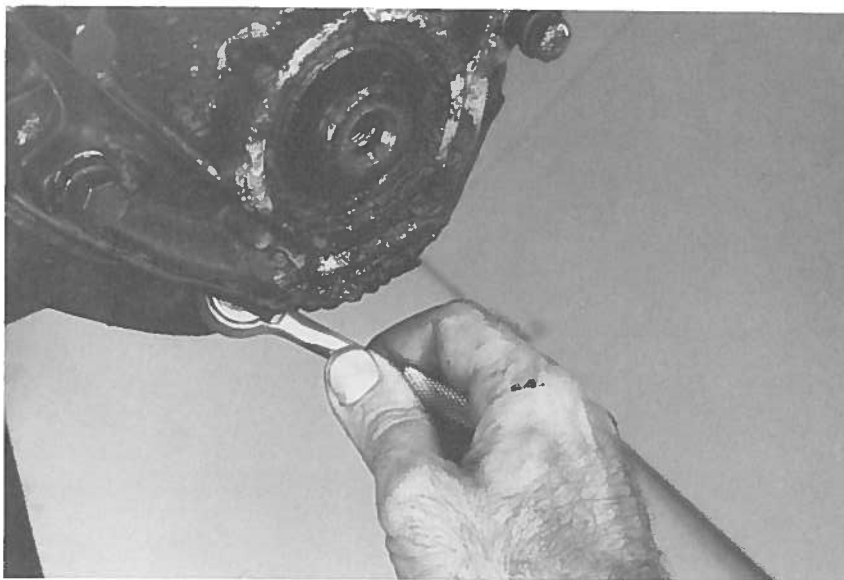
From a service standpoint, these keys don't need to be removed, as they don't get in the way of any machining or balancing operation. However, it's a good idea to remove them so that they don't get lost at the machine shop. Remove the key by tapping down on one end of it with a brass drift. Then tap the raised end with the drift to remove the key.

Timing Chain, Gears, and Damper

With the case off, the timing chain, gears and damper will be visible. Before you remove these parts, take a look at the timing chain where it is unsupported between the gears. Both sides should be fairly snug. If one side is drooping compared to the other, then the chain has a considerable amount of slack, which is a reliable indicator of wear. A loose timing chain will allow the ignition timing to vary beyond specifications, which, in turn, can cause driveability problems. And if the chain is quite loose, it's prone to slipping on the gears, which can lead to engine performance problems, such as a lack of power.

If you notice more than 1/4in of play when you move the loose side of the chain side-to-side with your fingers, the timing chain is loose and needs to be replaced. As a general rule, 60deg V-6s are extremely hard on timing chains and gears. Consequently, unless the engine has fewer than 5,000 to 10,000 miles on it, you would be wise to replace the timing chain and gears.

You need to replace the timing gears when you replace the timing chain, because the gears and the chain wear into a unique, interrelated pattern. If you try using a new chain on used gears, the new pattern grates against the old, shortening the life of both the chain and gears. And keep in mind that if the engine has a remotely mounted water pump, as found on a Cavalier or Cimmarron, you'll need a



Engines that use a two-piece oil pan gasket have two bolts that secure the

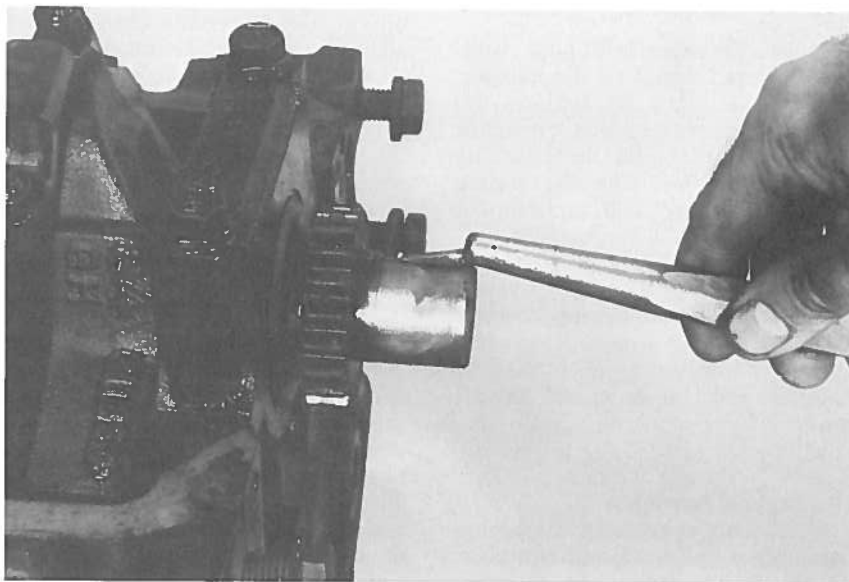
front of the oil pan to the timing chain case.

timing chain and gears that are 0.100in narrower than the regular timing chain and gear set for 60deg V-6s. That's because the timing chain case is narrower on these vehicles.

To remove the timing chain, remove the three bolts that hold the camshaft sprocket to the camshaft. Then grab both sides of the sprocket and wiggle it off the indexing dowel on the front of the cam. If the sprocket won't budge, tap its outer edge with a

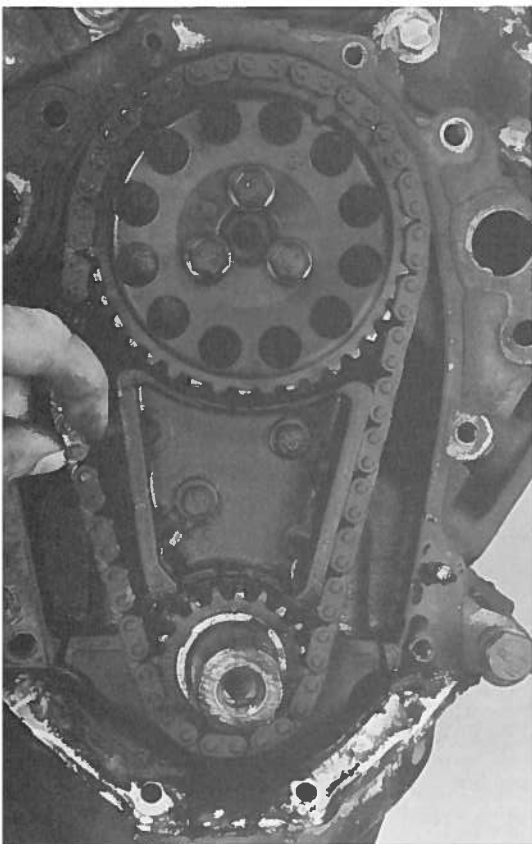
soft-faced mallet. When the sprocket is free, lower it slightly to disengage the chain from the crankshaft sprocket, then remove the cam sprocket and chain.

The timing chain damper is the V-shaped block that fits inside the timing chain. Its mission is to damp out oscillations in the timing chain that could reduce its life. If the timing chain has considerable slack, you'll probably need to replace the damper,



After gently tapping one end of the woodruff key with a brass drift, remove the key by tapping its raised end. After-

nately, you could lever it out with a small screwdriver.



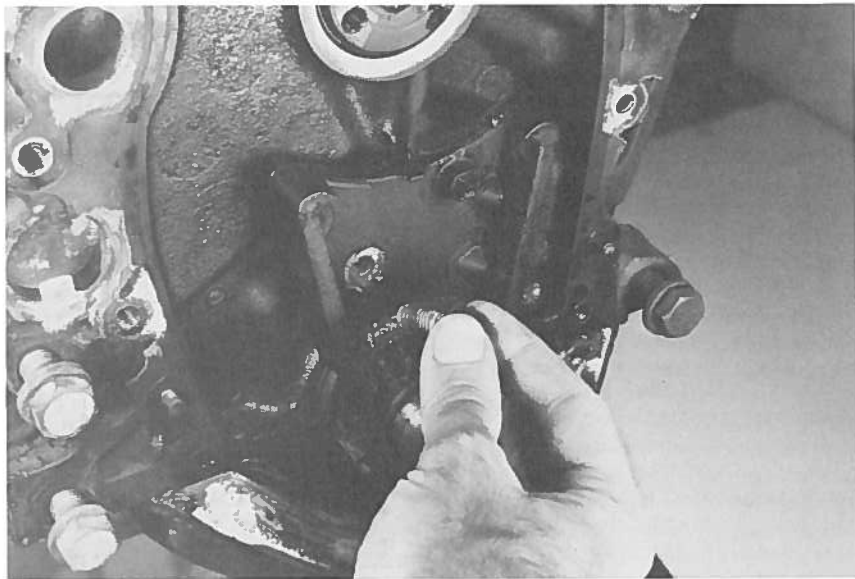
Pulling and then pushing on the timing chain in the area shown will tell you how worn the chain is. This timing chain has far too much slack. The timing chain and gears should always be replaced as a set because they tend to wear into one another.

because the chain will have worn through the coating on the damper. You'll also want to replace the damper if the rubber that surrounds it is hard, heat-checked, or is missing chunks. And just like the timing chain and gears, the replacement damper used on General Motors J-cars, such as the Cavalier, is 0.100in narrower than the standard guide.

To remove the damper, remove its two retaining screws. Then slide the tip of a screwdriver between its backside and the block, and lever it out.

Crankshaft Sprocket

All that remains of the timing assembly is the crankshaft sprocket. To remove it, use any two- or three-jaw puller with jaws that will fit behind the sprocket. (If you don't have a puller, a machine shop can remove



The timing chain damper is held in place with two bolts. Remove the bolts and then pull or lever the damper from

the block. In most cases, you should replace the old damper with a new one.

the crankshaft sprocket for a nominal charge.)

Lubricate the tip and threads of the puller center screw with wheel bearing grease, then slide the puller's jaws around the backside of the gear. Position the tip of the center screw into the bolt hole in the front of the crankshaft, then tighten the puller. When the puller is tight, tap the head of the center screw with a hammer to dislodge the gear. Alternate between tightening the center screw and tapping it with a hammer until you can slide the gear off the crankshaft.

On earlier engines, when the crankshaft sprocket is off, you'll find a woodruff key in the crankshaft, just like the one you removed for the damper. Remove it by tapping one end with a brass drift, then levering it out with a small screwdriver.

Intake Manifold

Before you jump in and yank the manifold, you should be on the lookout for tell-tale signs of trouble if the engine wasn't running as it should. For example, if your engine was idling erratically, the joint between the block and the intake manifold could be leaking. If this joint isn't sealed well, extra air is sucked into the cylinders, leaning out the air/fuel ratio and causing the engine to surge. On the other hand, if the engine's been leaking coolant, but you weren't able to pinpoint the source of the leak,

take a good look at the gaskets between the sides of the intake manifold and the cylinder heads. If these gaskets aren't sealing well, coolant can leak out of the engine, since the coolant passages in the heads are positioned at the ends of each head, or it can leak into the engine oil.

To remove the intake manifold, you must first remove the rocker covers, as their top edges overlap the manifold.

Some of the rocker cover bolts have a post on their back which provides a mounting point for the spark plug wire guides. Before you can get a deep-well socket over the bolt head, you need to remove the guides. Insert the blade of a small screwdriver into the joint of the guide, rotate the screwdriver to open the joint, and then slide the guide off the top of the post.

After removing the rocker cover retaining screws, use a rawhide mallet to break the seal between the rocker cover and the head. Several light blows on the end corner of the valve cover should be enough; if you strike the rocker covers too hard, you may dent them. Also, avoid prying the rocker cover off the head with a screwdriver, as you'll probably bend the rocker cover flange, creating the potential for a future oil leak.

With the rocker covers off, you can remove the intake manifold. The intake can be attached in one of two

ways: with six bolts and four nuts or with four bolts and six nuts. The nuts are used on studs that screw into the cylinder heads. After you remove the bolts and nuts, position a pry bar underneath the thermostat housing neck and lever the manifold up to break the seal between the manifold, heads, and block. When the seal is broken, pull the manifold straight off the studs.

With the manifold off, you'll see a gasket on the side of each cylinder head. These seal the sides of the intake manifold to the heads. Examine the surfaces of these gaskets carefully. Areas that are uncompressed indicate where coolant leaks (or vacuum leaks) could be.

Each of these gaskets uses a barbed fastener to retain it to the cylinder head. Pull the edge of the gasket away from the head to remove it. If you can't grab the gasket, carefully slide the tip of a screwdriver between the gasket and the head and lever the gasket up. Don't use a screwdriver on aluminum heads if at all possible; otherwise, you may scratch the machined surface, creating a potential leak path.

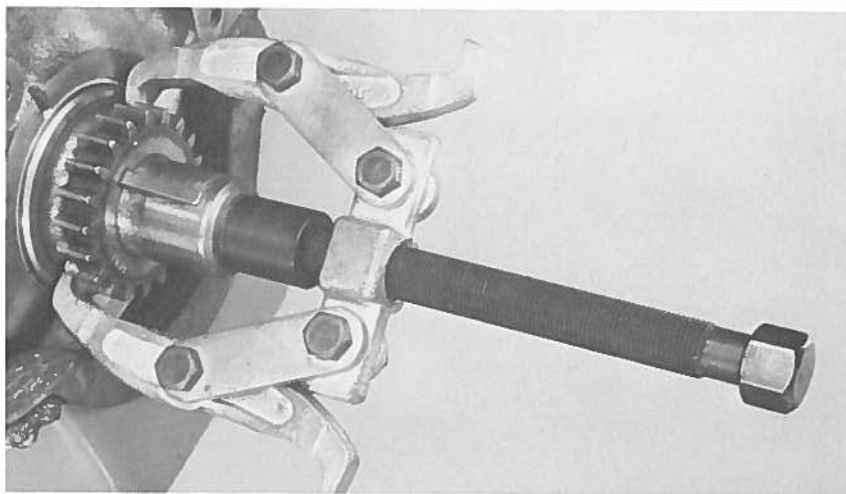
While the sides of the intake manifold are sealed by gaskets, RTV sealer is used at the front and rear of the manifold to seal it to the block. You can peel most of the RTV sealer away by hand and remove remaining residue with a gasket scraper. To prevent gouging, use a steel scraper for cast-iron heads and a nylon scraper for aluminum heads.

Rocker Arm Assemblies

Each rocker arm assembly consists of a nut, rocker ball, and rocker arm. Two types of rocker arm assemblies have been used: non-adjustable and adjustable.

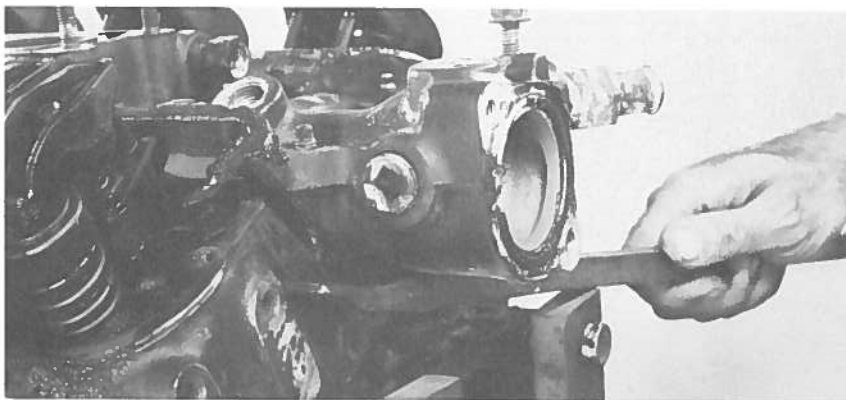
Non-adjustable rocker arms are used on splayed valve heads—that is, heads with valve stems that aren't parallel to each other. The nuts used with these rocker arms are simply screwed into position and then tightened to a specific torque. The rocker studs used with these rocker arms are also unique, in that they have a shoulder down at the bottom of the rocker nut threads which provides a positive stop for the underside of the rocker arm.

Adjustable rocker arms are a different story. The nuts used with these rocker arms are crimped slightly on the top, gripping the stud

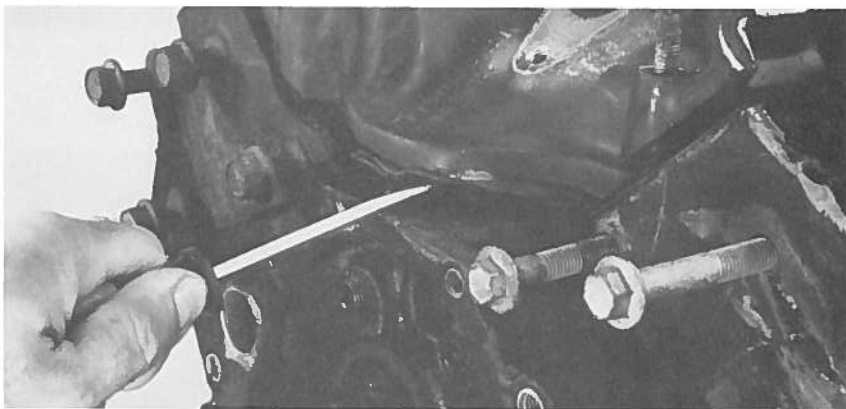


Make sure the puller legs are securely positioned behind the gear before hitting the center screw with a hammer.

With the gear off, remove the woodruff key from the crankshaft so that you don't lose it.

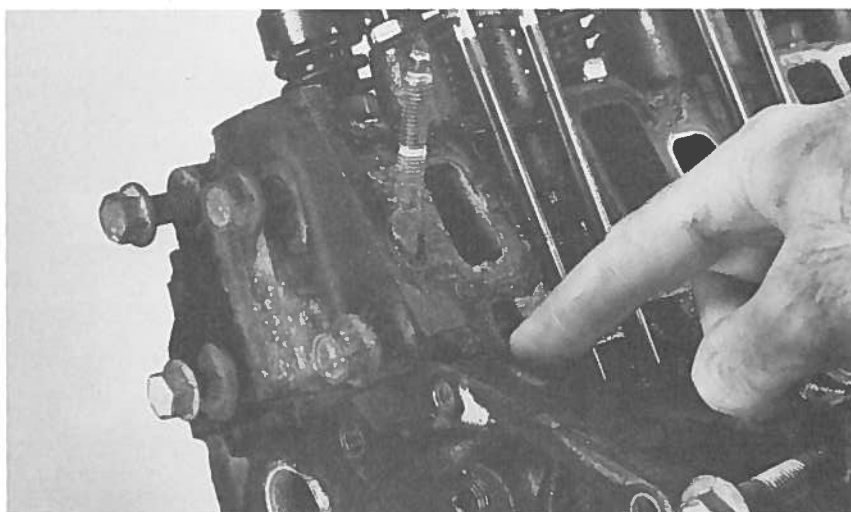


To break the seal between the manifold and the block, lever the manifold up underneath the thermostat housing.



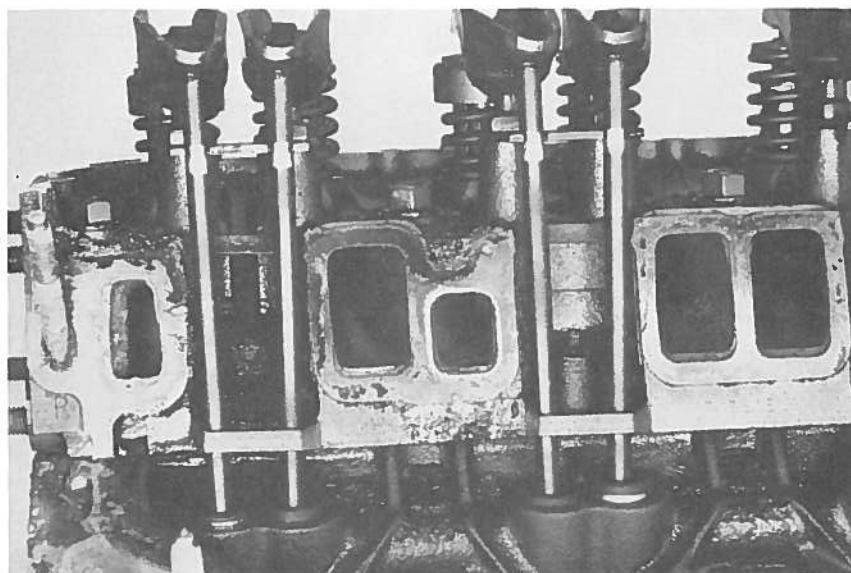
If the end of the manifold opposite the thermostat housing won't break free, you can use a screwdriver to lever the manifold up. Just don't scratch the manifold with it. Also, note the RTV

sealer on the bottom center of the manifold. RTV sealer is used to seal the ends of the manifold, while gaskets seal the sides.



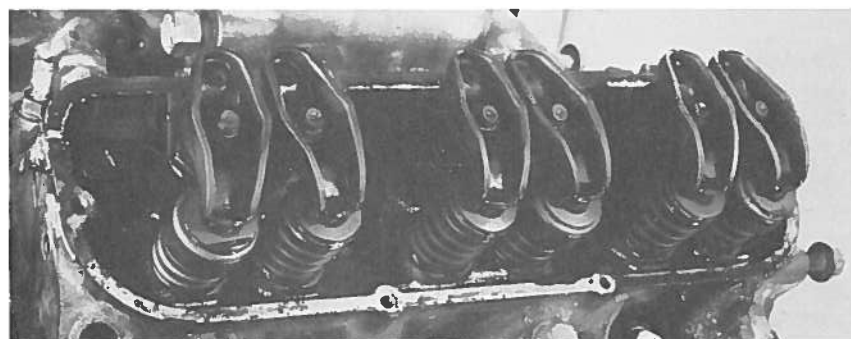
This area where the heads, block, and intake manifold all meet (one at each

corner of the manifold) is the area most likely to leak.



Gaskets are used at the sides of the intake manifold. These gaskets use a

barbed fastener to retain them to the cylinder heads.



A pair of rocker arms are fitted to each cylinder. If this were a splayed-valve

head, the rocker arms wouldn't be parallel to each other.

snugly to prevent unwanted movement of the nut after the rocker arms have been adjusted.

As you remove each nut, note how much force is required to turn it. If one nut is much tighter or looser than the others, it should be replaced. When removing the rocker arm assemblies, be sure to note which rocker arm stud you took them from so that you can reinstall them in the same positions.

Pushrods

With the rocker arm assemblies out of the way, you can remove the pushrods. Keep them in order so that you can reinstall them in their original position.

Lifters

The lifters are found in the valley of the block. As with the other valvetrain components, you must have some way of identifying which lifter fits in which bore if you plan on reusing the lifters. This prevents almost instantaneous cam lobe failure.

Before you remove each lifter, take a look at the outside of each lifter bore. In some cases, the factory uses a lifter with a diameter 0.25mm larger (oversize) than standard. This allows them to use a block that has some minor flaw in the lifter bore, but is in otherwise good condition. Factory honing the bore 0.25mm oversize corrects the problem. Consequently, the lifter has to be 0.25mm oversize as well to prevent a massive internal oil leak. Any lifter bores that are oversize are marked 0.25 OS near the top.

Be sure to note which lifter bores are like this, and if you plan on replacing the camshaft, be sure to order the proper number of replacement lifters from your GM dealer. (It can take seven to ten days to get these lifters, so order them early.) Unfortunately, oversize lifters aren't currently available from the aftermarket.

The removal technique for lifters depends on how worn they are and the amount of varnish in the lifter bores.

If the foot (camshaft end) of the lifter hasn't mushroomed and there's minimal varnish in the lifter bores, you can remove the lifters with your fingers, but if the varnish is a little heavier, you'll need to use a pair of needle nose pliers. Grab only the very top of the lifter to avoid damaging its outside diameter of the lifter, where it fits into the lifter bore. A few squirts

of carburetor cleaner around the outside of the lifter bore can help you remove stubborn lifters.

If the lifters refuse to come out the top of the lifter bore, there's probably a significant amount of varnish around the outside diameter of the lifter foot, or the hardening in the lifter foot has given way, causing the foot to mushroom. Either situation requires removing the camshaft and pushing the lifters out the bottom of the lifter bores.

Cylinder Heads

Eight cylinder head bolts secure each head. They're positioned so that four bolts encompass each cylinder, which helps to evenly distribute the clamping force around each cylinder and minimizes the chances for head gasket failure.

Before you loosen the cylinder head retaining bolts, remove the spark plugs, as they're much easier to remove now while the heads are still on the engine.

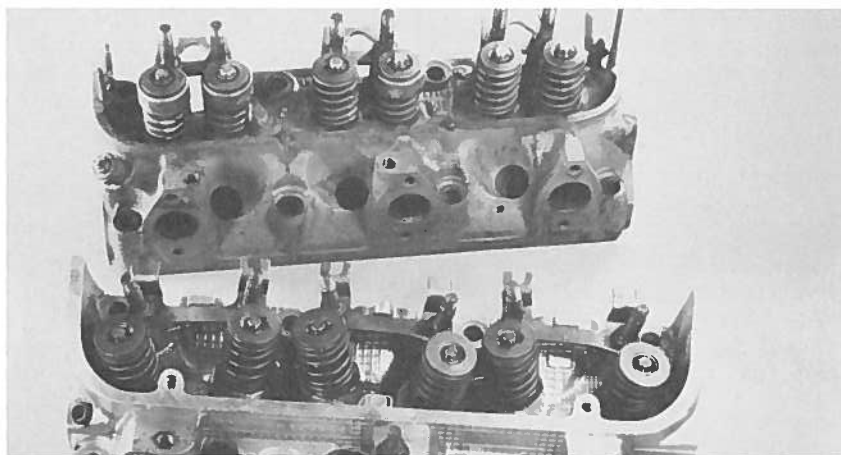
To remove the cylinder head bolts, you'll need a breaker bar, a short extension bar, and a 15mm socket. Don't use an extension bar longer than 6in, because you'll put too great of a side load on the bolt head. This can cause the socket to slip and round the bolt head.

As you loosen the bolts, pay attention to the amount of torque needed to loosen them. A bolt that turns significantly easier than the others may indicate that the coolant leak you were looking for is right here, or that the head gasket in this area wasn't clamped securely, leading to that compression leak. Note the position of any loose bolt(s) and be sure to check the head gasket in that area after you remove the head.

After loosening the head bolts, remove them all, except for two on the ends of each head. Keep these bolts screwed into the block three to four turns or so to prevent the heads from popping off and falling on the floor when you're breaking the bond between them and the head gaskets.

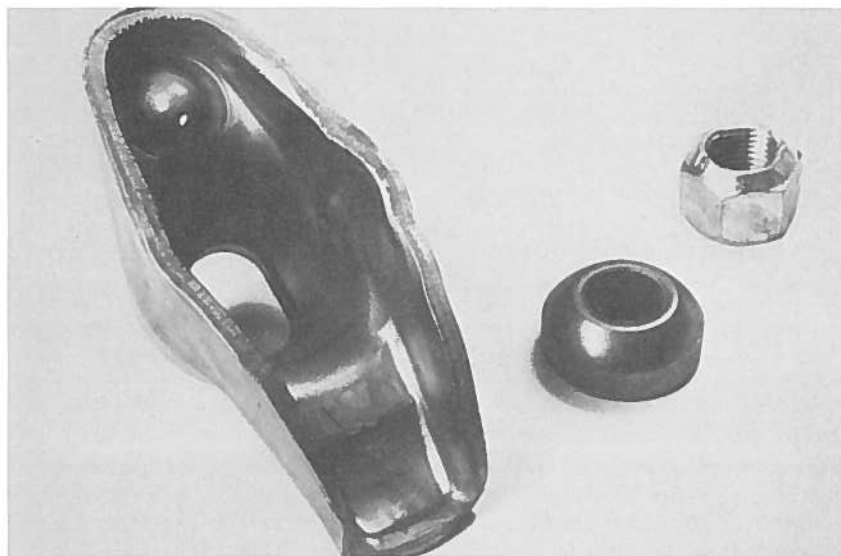
Breaking this bond usually requires inserting a pry bar between the edge of the head and the block, and levering the head away from the block. Be especially careful with aluminum heads so you don't damage their mating surfaces.

Once a head is loose, hold it while you remove the remaining head bolts. At this point, the head gasket



Compare the position of the rocker arms and pushrods in this splayed-valve head (bottom) with those on the cast-iron head. The position of the

valves and the shape of the combustion chambers make these heads more efficient than the parallel valve heads.



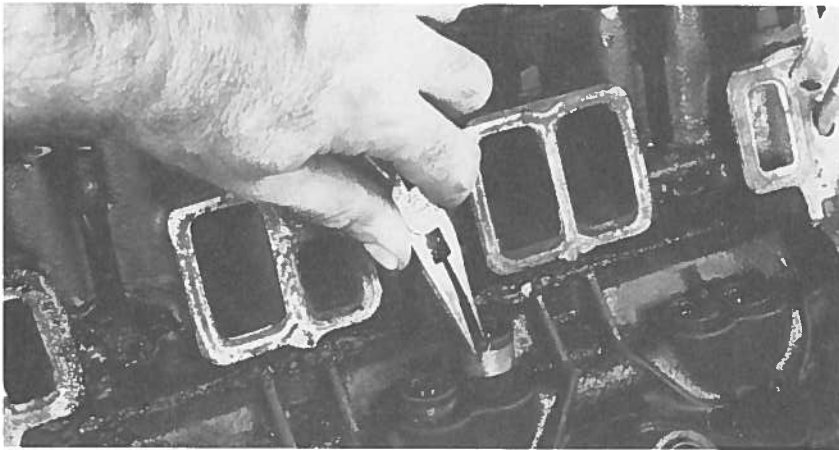
This is an adjustable rocker arm assembly. The end of the nut is crimped to prevent it from moving easily. Non-

adjustable rocker arm nuts aren't crimped and have an integral washer.



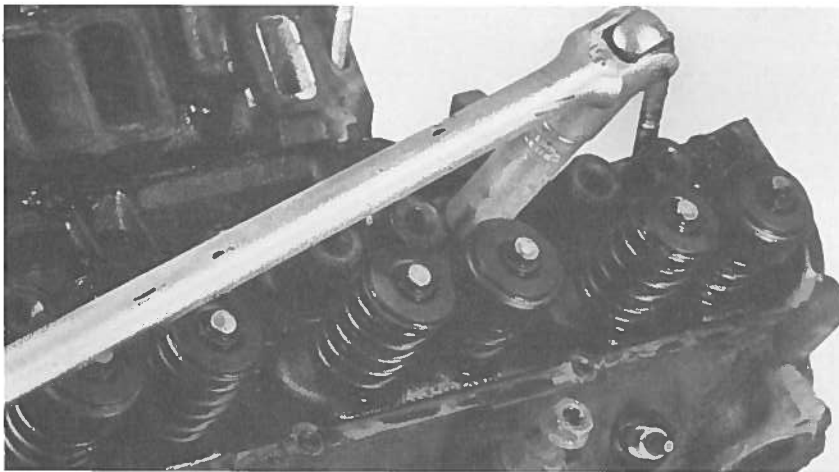
This engine uses adjustable rocker arms. The tip-off is that the rocker arm

studs don't have a shoulder below the upper threads.



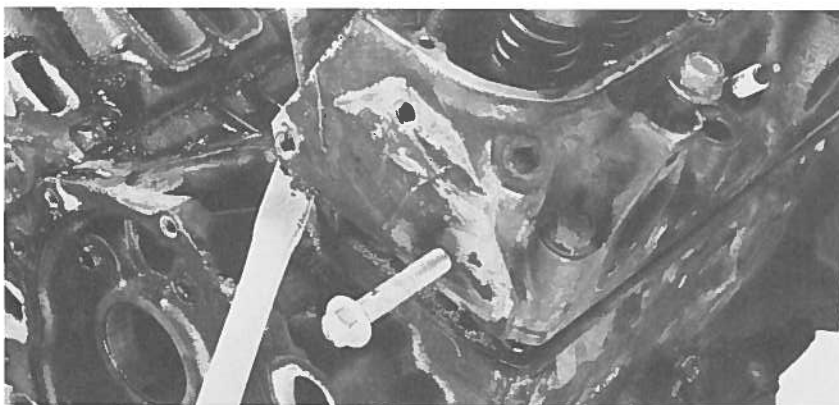
You may need to use needle nose pliers to remove those stubborn lifters. A few squirts of carburetor cleaner

around the outside of the lifter can make this job easier.



You'll probably need a breaker bar to loosen the cylinder head bolts. Don't use an extension bar that's any longer than necessary, because you'll round

off the bolt heads. Whatever you do, don't use air tools, because you won't be able to "feel" for problems the way you can with hand tools.



Use a pry bar to break the bond between the heads and gaskets. Note the bolt on the end of the head that keeps it

from falling off when the bond to the head gasket is broken. Another bolt is used on the other end of the head.

may still be clinging to both the head and block. To break this bond, tug the head sharply.

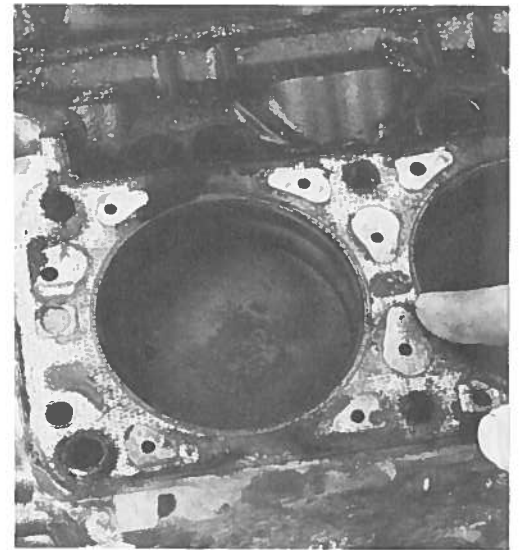
When the heads are off, don't lay them down on any of their machined surfaces, because you can damage their finish. Instead, stand the heads on end in a place where they won't get knocked over.

Carefully inspect the head gasket. Uncompressed areas indicate that the head bolts weren't tight in that area, one or more head bolts were broken, or you probably have a compression leak between these cylinders. This is a result of a recessed area in that particular area of the head or block. In turn, this problem can usually be traced to a loose water pump drive belt, insufficient coolant, or a blocked radiator, any of which would cause engine overheating.

If the head gasket wasn't compressed evenly and the head bolts were tight, you'll need to check the flatness of both the cylinder head and the block, as outlined in Chapter 5.

Removing the Valves

With the heads off the engine, you can remove the valves. But keep in mind that some cylinder heads use different methods of sealing the valves depending upon the year and model in question. Some heads use an O-ring near the top of the intake valve stem and another seal at the top of the intake valve guide, while others



When the heads are off, look closely at the entire surface of both head gaskets. Uncompressed areas indicate that the bolts in that area were loose or broken.



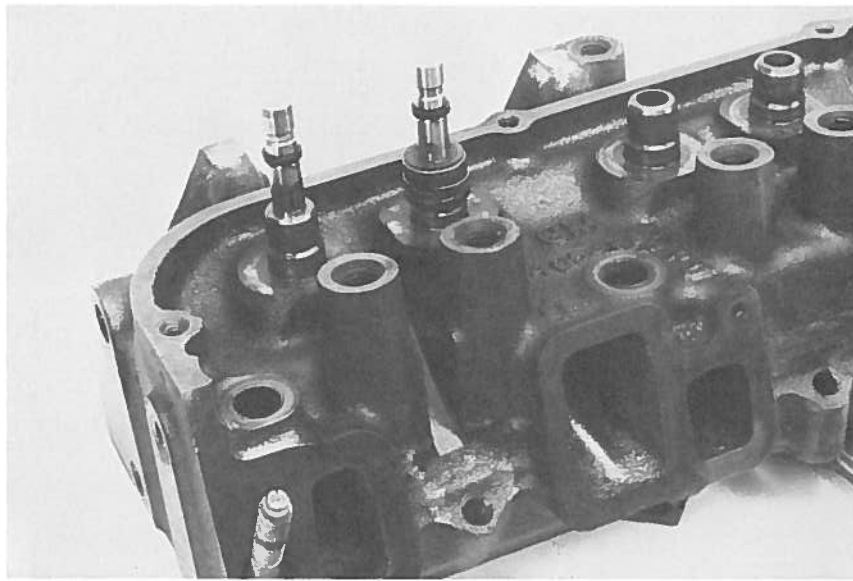
This is what a blown head gasket looks like. Note the metal banding of the fire ring around the cylinder. This is usually caused by overly advanced ignition timing or loose head bolts.

drop the O-ring at the top of the intake valve but keep the seal at the top of the intake valve guide. Also, the exhaust valves in some engines use rotators while others do not.

For purposes of explanation, we'll discuss the heads that use two seals on the intake valves and a rotator on the exhaust valves. This will provide you with enough information to tackle any of the variations on this theme.

You can remove the valves and their associated hardware at home if you have a spring compressor. A valve spring compressor looks like a large C-clamp and can be purchased at many auto parts stores and some department stores. Alternatively, you could have a machine shop perform this task for you.

Before you put the compressor on the head, select the compressor jaws that fit most snugly over the spring caps on the valves and secure them to the compressor with the screws provided. Before proceeding, put on a face mask, or at least safety



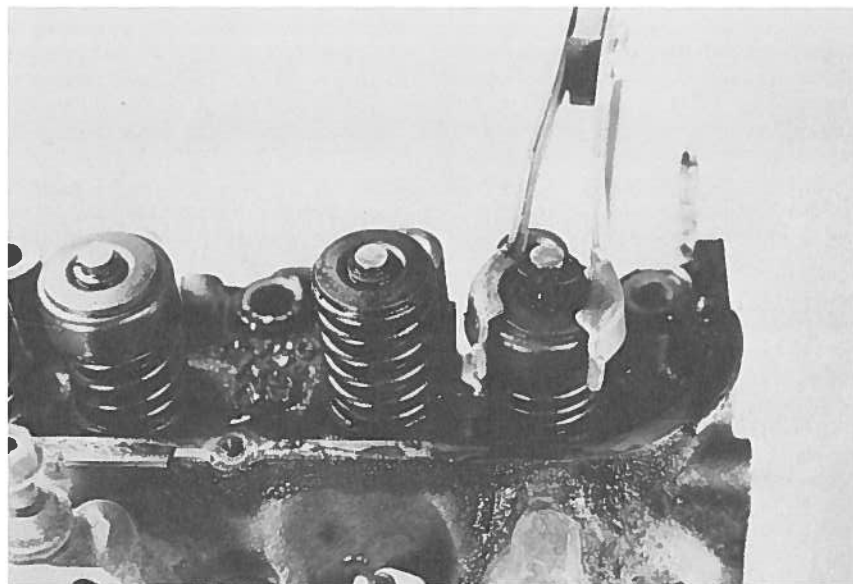
Some cylinder heads use an O-ring at the top of the intake valve and another seal on top of the valve guide. If the exhaust valves use rotators, they're posi-

tioned between the top of the valve spring and the valve stem locks, and are used in place of the valve spring cap.

goggles, to protect your face and eyes should a valve spring fly off the head. Put the compressor's jaws over the spring cap on the intake valve you want to remove. Align the moveable jaw of the compressor so it's centered over the valve's head. If the fixed jaws spread as you compress the valve spring, position a small pair of locking

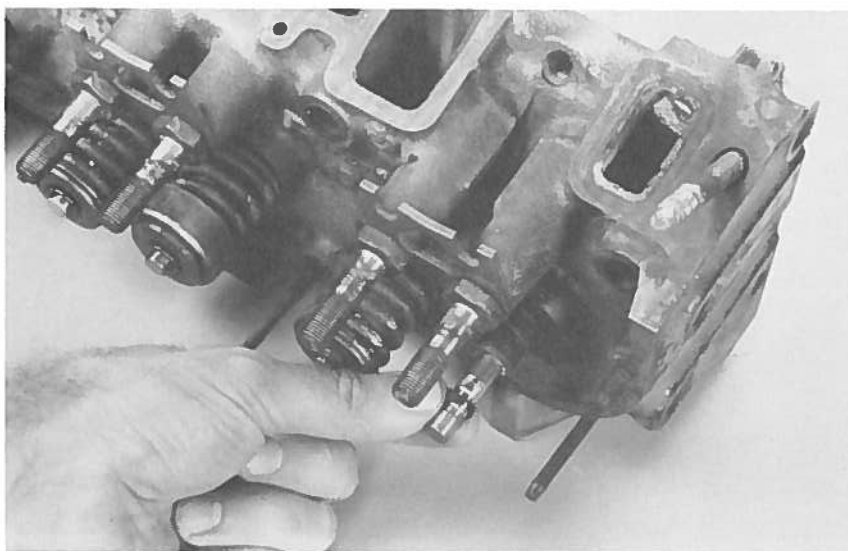
pliers over them. Then with the ratchet engaged on the compressor, turn the handle on the compressor so that it puts a slight load on the valve spring.

With the valve spring slightly compressed, use a rawhide or plastic mallet to lightly strike the jaws of the compressor at the valve spring. Do



With the valve spring compressed, the valve stem locks (also known as keepers) will be plainly visible. To remove

them, use a small magnet or needle nose pliers, not your fingers.



Remove the O-ring seal from the top of the valve (if used), then slide the valve out of the head. Be sure to note which cylinder it came from. If the tip of the

valve stem is mushroomed, grind the mushroomed portion off before removing the valve. Otherwise, you'll destroy the valve guide.

this once or twice. This impact will break the seal between the valve spring cap and the spring, and you'll see them separate. If you don't perform this step, you'll be putting a greater load on the compressor than necessary, increasing the potential for the spring to fly out of the compressor. Also, be sure not to strike the valve stem, as you can bend it.

Now, using a small magnet or needle nose pliers, compress the

spring enough to remove the valve stem locks from between the spring cap and valve stem. Don't be tempted to use your fingers, because the compressor's jaws may slip on the cap and the spring will surely catch your fingers as it flies across the room.

When you have removed the valve stem locks, slowly release all the tension on the valve spring. Then remove the compressor from the head and the locking pliers from the com-

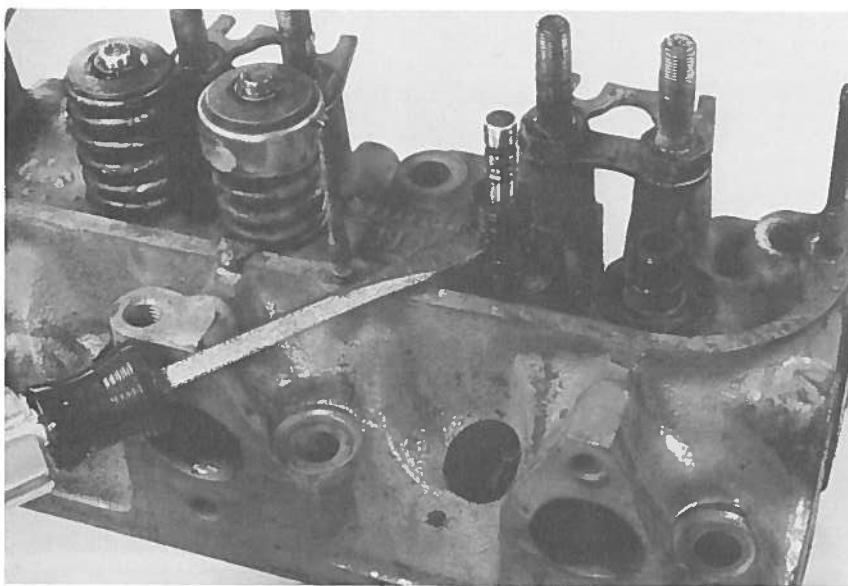
pressor jaws. This will allow you to remove the valve spring cap from the compressor jaws and the valve spring and damper from the cylinder head.

Continue disassembly by removing the valve stem seal from the lower top groove on the valve stem and sliding the valve off of the head. Finish by sliding the tip of a flat-blade screwdriver under the guide-mounted seal and lever it off.

As you disassemble the exhaust valves and springs you'll notice that they have an oil shedder, whereas the intake valves do not. Also, some engines use a valve rotator in place of the valve spring cap. This little wonder looks like an extra-thick washer and sets on the top of the valve.

Appropriately enough, the valve rotator's job is to rotate the exhaust valve every time it closes. This reduces carbon build-up on the valve and the seat. Excessive carbon deposits between the valve face and seat prevent the valve from dissipating heat into the coolant via the valve seat. Without any way of shedding this heat, the edges of the exhaust valve just get hotter and hotter, and will actually begin to melt away! Rotators aren't used on intake valves, because they operate at a significantly lower temperature than exhaust valves.

Complete the exhaust valve re-



You can remove guide-mounted seals by levering them off with a screwdriver.



As soon as you pull the cam out of the block, support it with your free hand to prevent scratching the camshaft bearings with the cam.

removal by removing the seal from the top of the valve guide (if it uses one) by levering it off with the tip of a screwdriver, then sliding the valve out.

Camshaft

There are a couple of different ways to remove the camshaft from the block. Whichever way you choose, you want to avoid damaging the camshaft lobes, journals, and bearings, so work slowly and carefully.

To lift the camshaft out, you'll need to install a "handle" on it. One way of doing this is to secure the camshaft sprocket to it. Alternately, you can use three bolts 4-5in long screwed into the front of the cam.

With your "handle" attached, slowly pull the camshaft out of the block. As soon as you've pulled the camshaft far enough out to grasp it with your hand, do so, so that you can keep the rear of the cam from dropping. Rotate the cam back and forth slightly while you pull it out, and keep sliding the hand that's holding the cam toward the block as you pull the cam out. This will provide more support for the cam the farther you pull it out. While watching the cam through the lifter lobes, slowly pull it out of the block, taking care not to damage it.

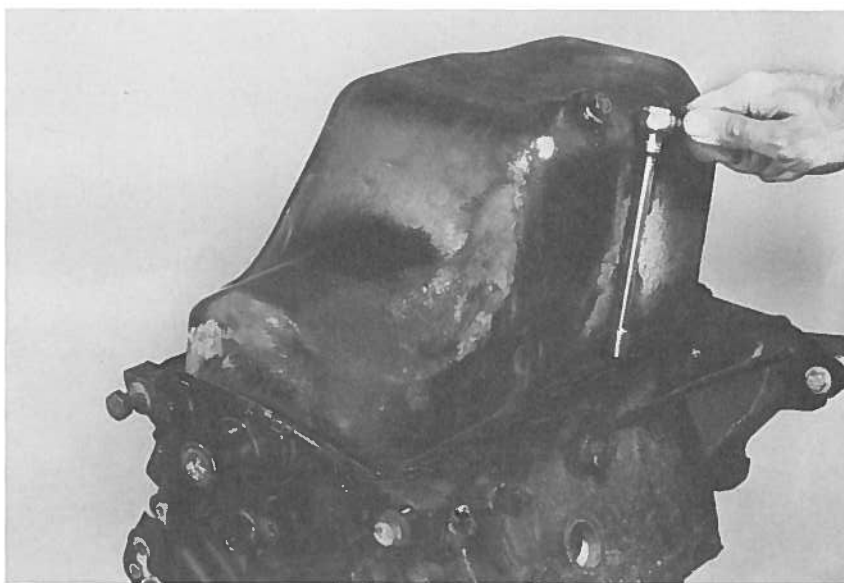
If you can't pull the cam out, its rear portion may have dropped and is hanging up on the block. Make sure the cam is even with the cam bearing bores and pull it out of the block. Also, if you weren't able to remove a lifter from the top of the block, it could be catching on the camshaft lobes, preventing you from removing the cam.

When the cam is removed, look for mushroomed lifters and be sure to check the cam lobes they mate with. If the lifter foot is mushroomed, its corresponding camshaft lobe is usually damaged as well. If any lobes are damaged, the cam and lifters must be replaced.

Oil Pan

If the engine's on an engine stand, carefully rotate it until it's upside down, thus giving you easy access to the oil pan retaining bolts. If you look closely, you'll see two larger bolts at the rear of the oil pan; these bolts are required to clamp the oil pan gasket securely across the rear main bearing cap.

After removing all the bolts, break the seal between the oil pan and block by taking your rawhide



Since the front lip of this oil pan is angled, you know that the oil pan uses a two-piece gasket. If the front of the pan

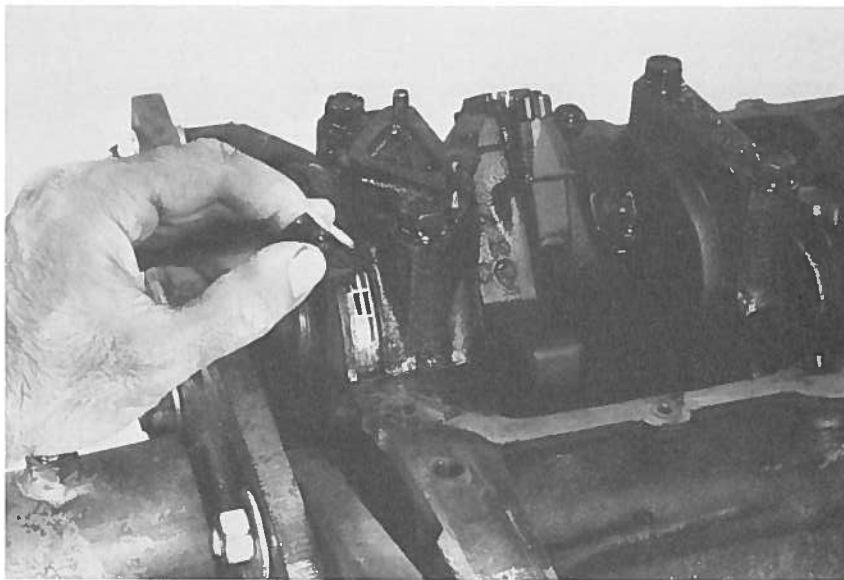
were at a right angle to the sides of the pan, a one-piece gasket would be used.

hammer and tapping a corner of the oil pan forward or rearward. It'll probably take a few gentle taps to free the pan. Avoid sliding a screwdriver between the lip of the pan and the block to lever the pan away, because you'll probably bend the flange on the pan. Also, if your engine fits a 1987 or newer vehicle, you may ruin the expensive one-piece rubber pan gasket, which, in most cases, is reusable.

Oil Pump

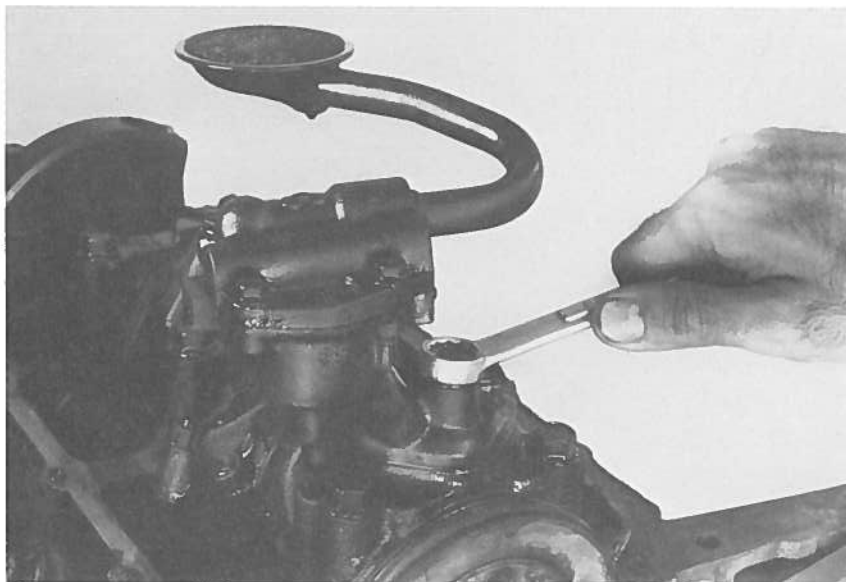
One bolt secures the oil pump to the rear main bearing cap. After removing the bolt, you'll have to rock the pump back and forth to remove it from the locating dowels on the bearing cap.

Use a magnet to determine whether the pump on your engine has an aluminum body. If so, you will need to replace it with a cast-iron ver-



Two-piece oil pan gaskets use a rubber seal across the back of the rear main

bearing cap. Remove the old one and discard it.



One bolt holds the oil pump in position. Remove the bolt and rock the pump back and forth to free it from the locating dowels on the bearing cap. If the

pump has an aluminum body, discard it. Aluminum-bodied pumps can fail almost instantaneously, destroying the engine when they go.

sion for two reasons. First, the aluminum cover used with this pump tends to wear at an accelerated pace, which can lead to a reduction in oil pressure. And, second, in some pumps, the idler gearshaft can work its way out of the pump and right into the path of a crankshaft counterweight. Due to these potential problems, you're better off with a cast-iron pump.

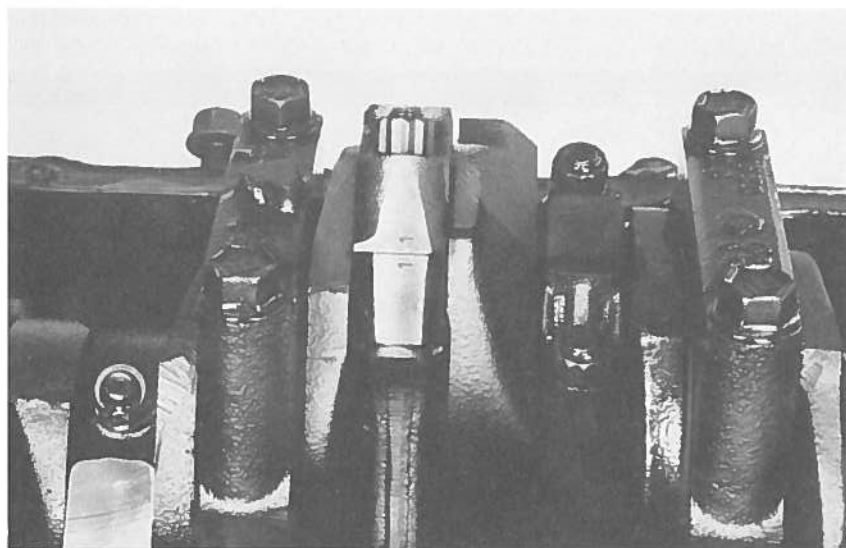
Piston Assemblies

Piston assemblies consist of the connecting rod, piston, piston pin, and piston rings. Before you remove the piston assemblies, you need to mark each connecting rod and rod cap so that you can identify the cylinder in which it was originally positioned. This ensures that the wear patterns on the pistons and cylinders remain compatible with each other, and that

the engine will remain balanced if you reuse the old pistons and connecting rods. Mark each rod and cap with a prick punch, number punch, or self-powered punch. Mark the same side of each rod and corresponding cap on the flat provided so that when you assemble the cap to the rod, you'll know the cap is on backwards if the numbers aren't on the same side (provided the caps were installed properly in the first place). You may notice that some connecting rods and/or caps are already marked. These marks are used for classifying the rods at the factory and do not match them to a particular cylinder. Make your own identification marks.

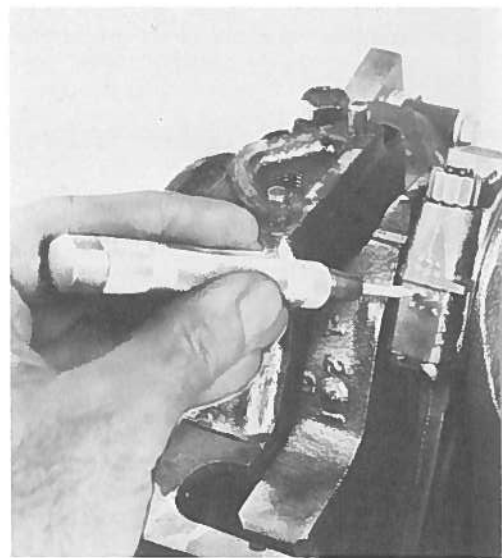
Before you remove the piston assemblies, look at the tops of the cylinders. If there is a metal ridge of more than 0.002–0.003in, you'll have to remove it before you remove the piston assemblies, or you may damage the piston and rings. You can do this with a ridge reamer, which is a tool that expands to fit the cylinder and has a cutting tool on its outside edge. By rotating the bolt at the top of the tool, the cutter gradually cuts the ridge away.

To remove a piston assembly from a cylinder, remove the connecting rod nuts with a twelve-point socket. Rotate the crankshaft as necessary to access these nuts. When the nuts are off, you'll need to "walk" the

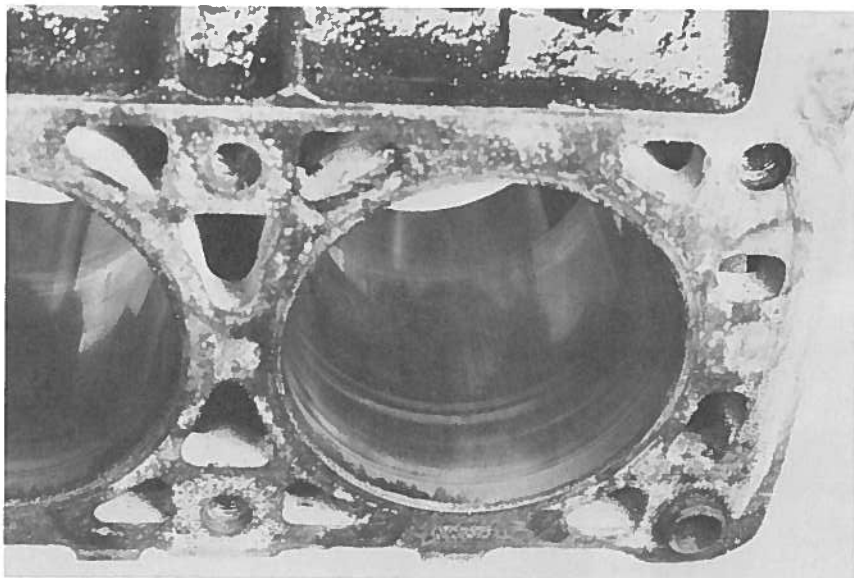


Don't mistake the numbers on the side of the connecting rod and cap for cylinder position numbers. These numbers

are for factory use. You should mark the true cylinder positions with a punch.



Mark each rod and cap on the same side and with a number of dots representing the cylinder its fitted to. This will help ensure that the caps are installed in the proper way on the correct rod.



After tens of thousands of miles, a metal ridge can form at the top of each cylinder as a result of piston ring wear.

If this ridge is greater than 0.002in, it must be removed before removing the piston assembly.

cap off the rod. One of the safest ways of doing this is to use a brass drift on the tangs of the cap, but you could also gently tap each rod bolt with a soft-faced mallet until the cap is free of the rod. If you choose this method, don't use a steel hammer because you may damage the threads on the bolts. Also, be sure to keep your feet clear of the cylinder you're working on, because if the rings on the piston assembly you're removing are broken, the piston can slide out of the cylinder. Keep your hand over the top of the cylinder to prevent this.

To "walk" the cap off the rod, make sure the connecting rod is pointing straight up the cylinder, then gently tap the bolts toward the piston while making sure the cap doesn't cock on the bolts. If the cap stops moving, it's probably hanging up on the bolts. You can free it by tapping the side of the cap that's highest until the cap is square to the bolts once again. Then resume your "walking" until you can pull the cap off the rod.

As you remove the connecting rod cap, note the location of the bearing tang on the rod cap. It should have been positioned on the same side as the bearing tang in the rod. If it wasn't, take a close look at both the bearing and the crankshaft journal it encompassed.

Bearing caps that were installed backwards are usually offset side-to-side and front-to-back, resulting in ex-

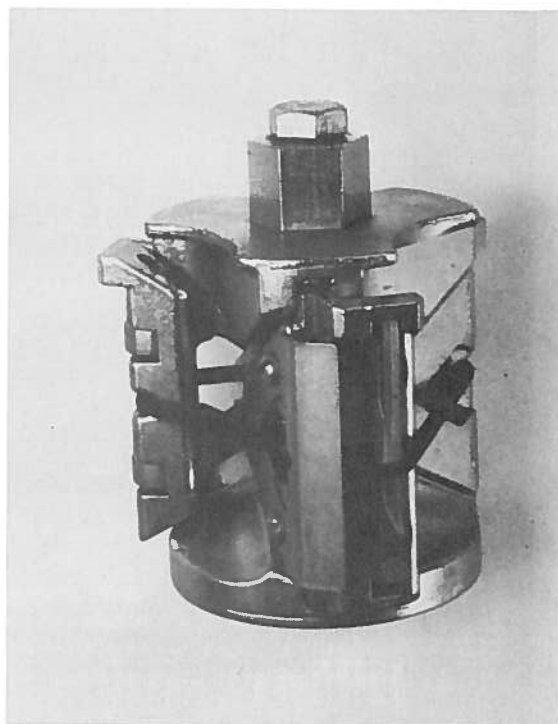
treme wear on one side of the bearing and accelerated wear of the crankshaft journal. If this happened, the bearing will have to be replaced and the crankshaft ground.

With the cap off the rod, the threads on the rod bolts can damage the crankshaft as you're removing the piston assembly from the block. In extreme cases, this damage can lead to failed bearings or a broken crankshaft. To minimize the potential for this, cover the bolts with rod bolt covers or 3/8in inside diameter fuel line hose. If you opt to use the fuel line, make each piece about 8in long so that you can use the hose to help guide the rod onto the crankshaft during assembly.

To remove the piston assembly, link a couple of extension bars together until you have a 1ft long extension. Then wrap one end of it with a few layers of duct tape. Put the end with the duct tape against the underside of the piston and firmly push the piston out of the bore. If the piston won't come out of the bore, *lightly* tap the extension bar with a hammer. If the piston still won't come out of the cylinder, push it back down the cylinder and check for a substantial ridge at the top of the cylinder; if one exists, remove it with a ridge reamer.

Main Bearing Caps

Before you begin removing the main bearing caps, look at them



A ridge reamer is required to remove the metal ridge from the top of the cylinder. Removing the ridge helps prevent damaging the piston and rings during their removal.

closely. They should all be numbered (except the rear main cap) from one to three, starting at the timing chain end of the block and moving toward the flywheel. If they're not numbered, mark them with your punch. The caps also have an arrow cast into them that must be pointing toward the timing chain end of the block. If the arrow on any cap is pointed toward the flywheel, there is trouble with that main bearing and possibly the crankshaft.

Understand that bearing caps are honed when they're in position on the block. If the caps are turned around or are in the wrong (incorrectly numbered) position, they will be slightly offset relative to the main bearing bore in the block. This will cause one side of the main bearing to be closer to the crankshaft than it ought to be. It could even touch the crankshaft, causing extreme wear of the bearing in a short period of time and may even allow the metal backing in the bearing to contact the crankshaft, damaging it.

So if you find a main bearing cap in the wrong position or turned around, take a good look at the bear-



You can use a brass drift to walk the cap off the rod. Make sure your hand is over the top of the cylinder to prevent the piston from falling to the floor. This can happen if the rings are broken. As

each rod cap is removed, closely inspect the bearing and the crankshaft journal. If they are damaged the bearings will need to be replaced and the crankshaft ground.

ing for that cap. Chances are that it's severely worn near its edge. Even the crankshaft may be damaged. If you find this type of damage, you'll need to replace the bearings and have the crankshaft ground.

To remove the main bearing caps, loosen the bolts and screw them out of the threads in the block, but don't take them out of the cap. In-

stead, use the bolts as "handles" to rock the cap back and forth to free it from the block.

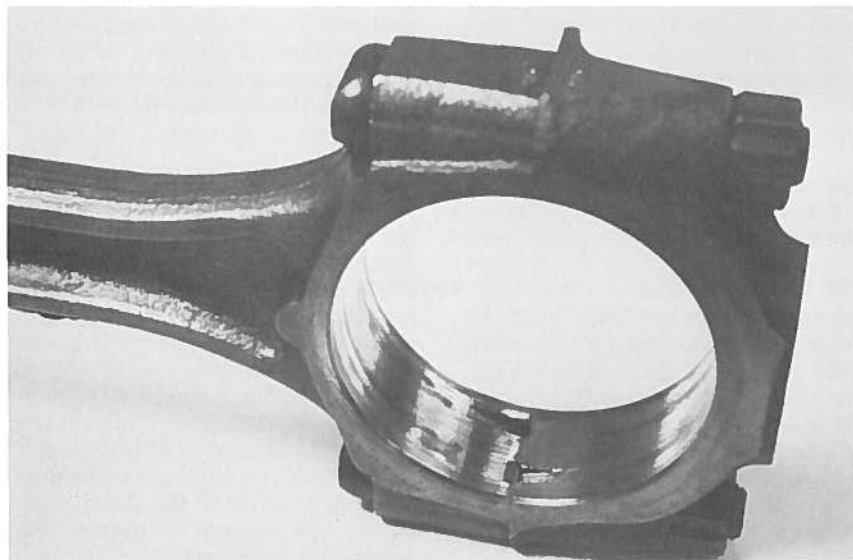
Lower Main Bearings

The lower main bearings will come out with the bearing caps. Since these bearings take the lion's share of the load (except the front main bearing), they wear the most and are the

most indicative of the condition of the crankshaft. For information on "reading" bearings, see the "Engine Bearings" sidebar in Chapter 5.

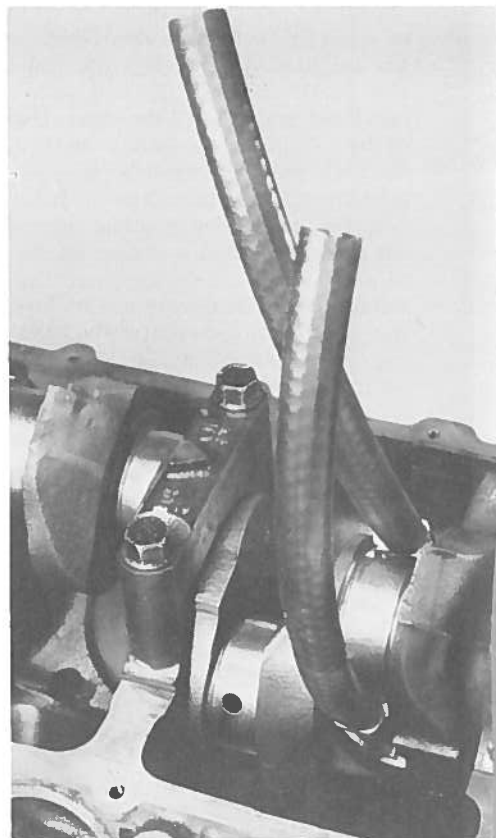
You should also note that all the main bearings are different widths. On small-journal crankshafts, the narrowest bearing is fitted to the #2 position. The next-wider bearing is in the #1 position. The bearing with the flanges is fitted to the #3 position, and the widest bearing is in the #4 rear main bearing position.

Except for some of the first large-journal engines in 1985 which used different-sized main bearings like the small-journal crankshafts, all large-journal crankshafts use identical main bearings for the #1 and #4 (rear main) positions. As with small-journal crankshafts, the main bearings used in the #2 position are the narrowest of the large-journal bearings, and the #3 bearing has thrust flanges.



The reliefs in the rod and cap that accept the bearing tangs must be on the same side. If not, excessive bearing and

crankshaft journal wear could result. Check the rods as you remove them for this potential assembly problem.



Before removing the piston assemblies from each cylinder, cover the rod bolts with protective covers or 3/8 in ID fuel line hose. This will help prevent damaging the bolt threads, crankshaft, and cylinder.



If the other side of the piston skirt looks as good as this side does with its prominent circumferential grooves, and if piston-to-bore clearance is acceptable, the piston can be reused.

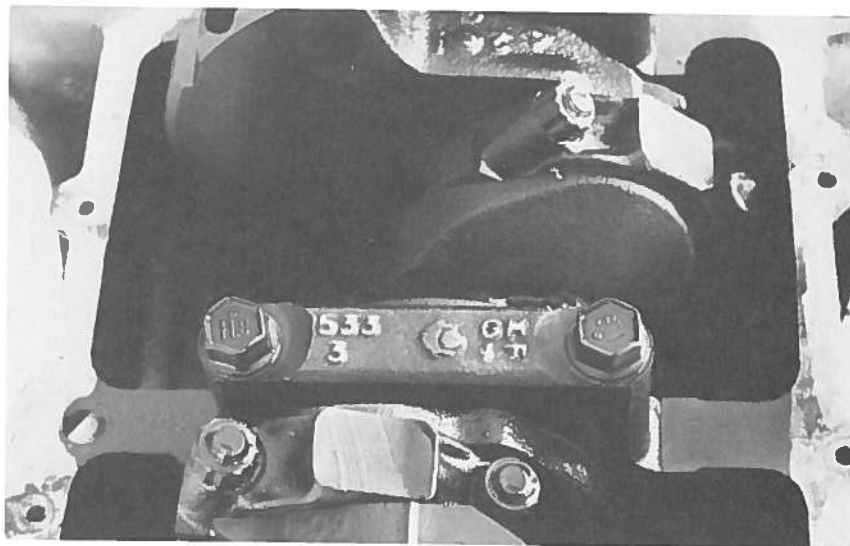
Crankshaft

The next step is to remove the crankshaft. It's heavy enough to break bones if it drops on your feet, so make sure you have a good grip on it as you're removing it from the block. This is no problem at the front of the crank, since its nose is readily exposed, but the rear isn't really long enough to get a good grip on. To ease removal, make gripping handles by screwing two flywheel bolts into it.

To get the crank out of the block, pull it straight away from the block. If you cock it, its thrust flange will hang up on the sides of the #3 main bearing. Once the crank is out, stand it up on the flywheel flange in a clean, safe place.

Upper Main Bearings

Now remove the upper main bearings by pushing the side of each bearing at its mid-point with your finger. The bearings will pivot out of their bores, and as you remove them, you should feel them "spring" out-



The "3" under the number 533 indicates that this is the #3 bearing cap. The arrow underneath the "G" in GM points to the front (timing chain end) of the block.

If the cap isn't in the right position or is installed backwards, check the bearing and crankshaft for signs of damage.

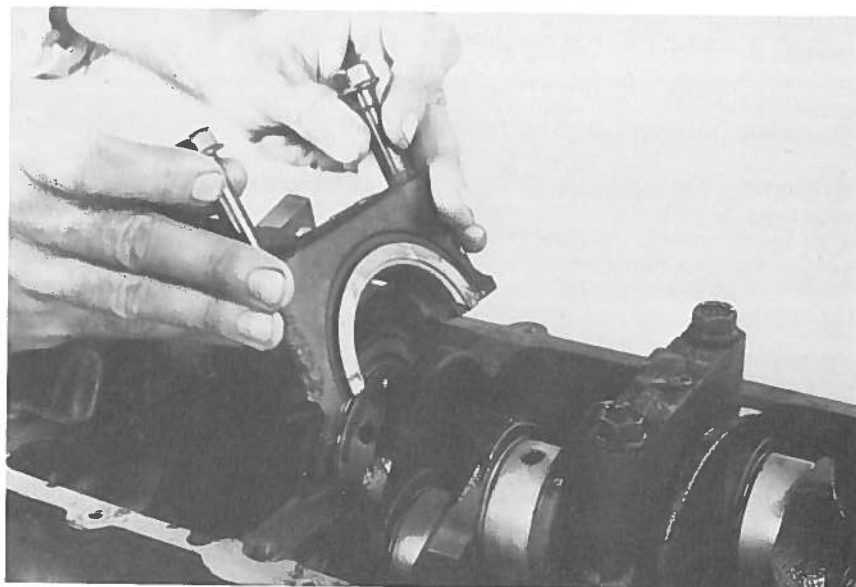
ward slightly. If they don't, they've lost their outward tension and should be replaced.

Cylinder Block Oil Gallery Plugs

Eight plugs are used to seal the oil galleries. Two each are used at the front and rear of the block, and are positioned to the side and above the camshaft. Another is positioned at the lower left corner of the rear of the

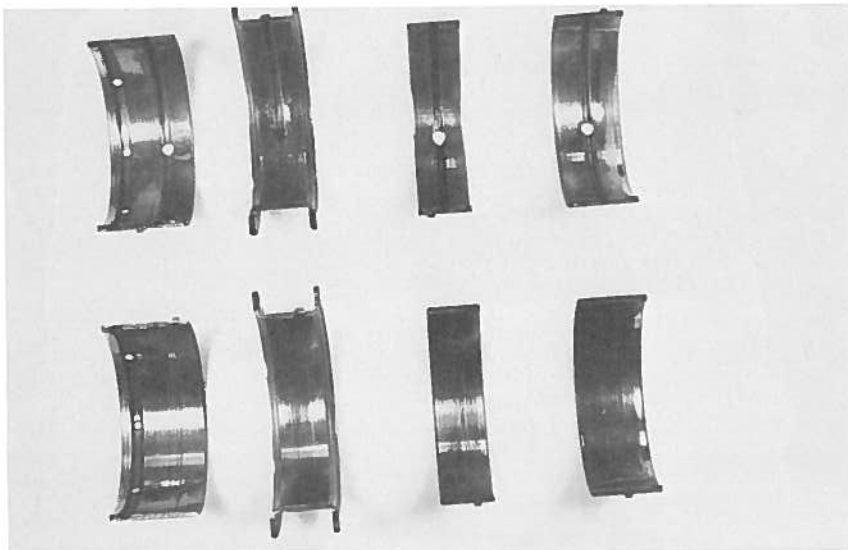
block. The other three plugs are smaller and are found in the lifter valley.

To clean the block completely, you have to remove all of these plugs. In most cases, they can be removed using a ratchet equipped with an appropriately sized extension bar. Just fit the end of the extension bar in the square hole in the plug and loosen the plug. If you can't remove the plugs using this method, try an impact driver,



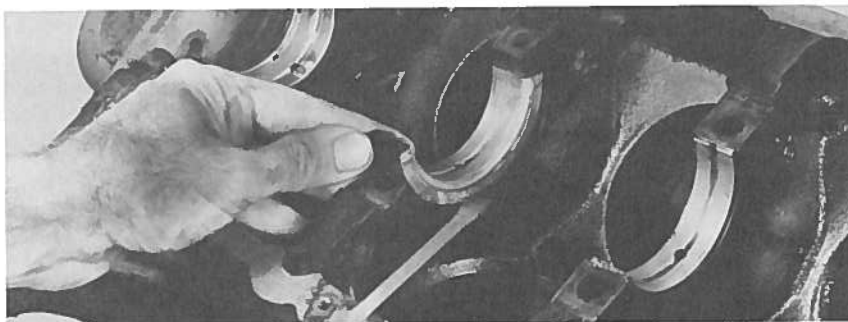
Use the cap bolts to rock the main bearing caps free of the block. If this doesn't

work, lightly tap both sides of the cap in an upward direction to remove it.



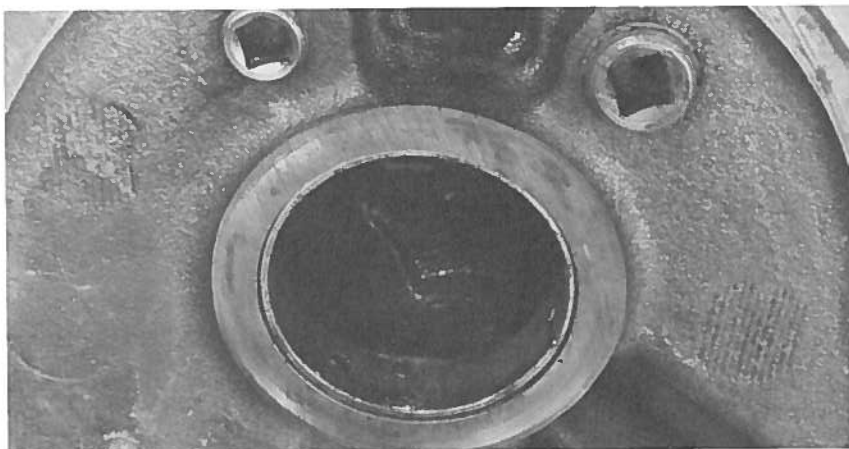
These are the main bearings in sequence from left to right: rear main, #3 (thrust) bearing, #2, and #1. The upper main bearings are grooved and fit into the block. The lower bearings generally

show the most wear and fit into the bearing caps. Due to the accessory drive belt loads, the #1 main bearing upper insert wears more than the lower insert.



To remove the #3 main bearing, lever it out with a screwdriver. You can push

the other bearings out sideways with your fingers.



These threaded plugs seal the front of the oil gallery. Two similar plugs are used at the back of the block, above the camshaft.

Another plug is used on the back of the block near the lower left corner.

or have the local machine shop do it.

Bypass Valve

To ensure the block is totally clean, you'll also need to remove the bypass valve. On engines that don't use a filter adapter, the valve is located inside the oil filter mounting boss on the block. On engines that use adapters, such as rear-wheel-drive vehicles, it's inside the adapter. To remove the plug, slide the tip of a small screwdriver into its middle, then lever the plug out. Replacement plugs are available from GM dealerships and better-stocked engine rebuilders.

Core Plugs

Some people refer to core plugs as freeze plugs, mistakenly believing that these plugs are designed to pop out of the block if the coolant freezes, thus relieving pressure in the block and saving it from cracking. The reality is that if these plugs pop out as a result of the coolant freezing, chances are good that the block is cracked as well. Core plugs were designed simply to plug the holes in the block that were used to remove any core sand from the casting process.

The core plugs in the block should be removed and replaced during the normal course of service. Over the years, corrosion can take its toll on the cooling jacket in the engine. The core plugs are the weak link in this because they're substantially thinner than the block. Since there's no good way to test the condition of the core plugs without damaging them, you're better off replacing them now. If an old core plug at the rear of the block develops a leak later, you'll have to remove the engine again to repair it.

Six core plugs are used in the block: one at the front, one on each side, and three in the rear. To remove the front and rear plugs, knock the plug into the block with a hammer and socket, then lever it back out of its hole with a pry bar or heavy-duty screwdriver.

Removal of the core plugs on the side of the block is somewhat different than the traditional method of knocking the plug sideways and then levering it out, because the cylinder bores are positioned almost directly behind each plug. This limits the distance you can move the plug. To overcome this problem, use the following two-step approach. Take a cold chisel that's about 1/2in wide and punch a

hole through the flat surface of the plug. Use the corner edge of the chisel to break through the plug as quickly as possible so you don't start moving the plug. Just be careful not to gouge the plug bore with the chisel. Then slide the end of a pry bar or sturdy screwdriver into the hole in the plug and lever it out of the block, using the block as a fulcrum.

Unfortunately, the plug sometimes falls into the block as you're working on it with the chisel. If this happens, you'll have to fish for the plug, bring it back to the hole it came out of, and lever it out. In some instances you might be able to use vise grips to grab the plug and lever it out.

Camshaft Plug

The camshaft plug at the rear of the block seals the back of the camshaft bore. This stamped plug is retained to the block with three screws and is sealed with RTV sealer or a rubber gasket. After you've removed the screws, slide the tip of a screwdriver underneath the edge of the plug and lever it off the block. Don't worry about damaging the RTV sealer or gasket, as you'll be replacing it.

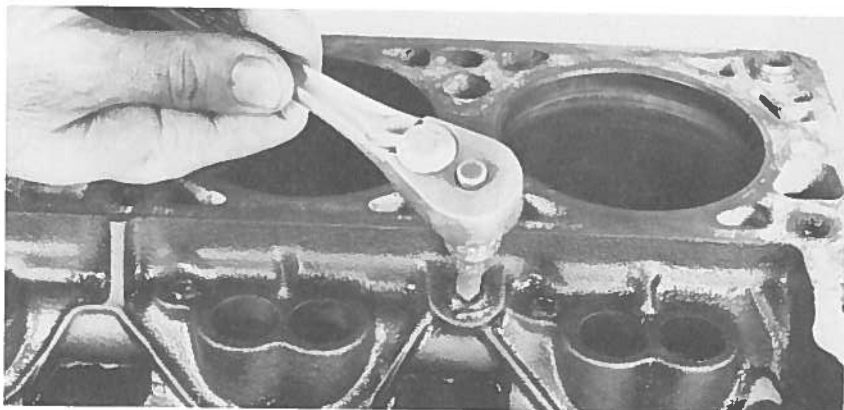
Camshaft Bearings

Due to their relatively understressed job in the engine, camshaft bearings usually have a long life. Unless you've damaged them severely while removing the cam, the engine had a severe internal oil leak that you couldn't locate, or the engine has extremely high mileage, you won't need to replace them.

However, if you have any of the above stated problems, or the block is going to be hot-tanked (which destroys the plating on the bearings), plan on replacing the bearings.

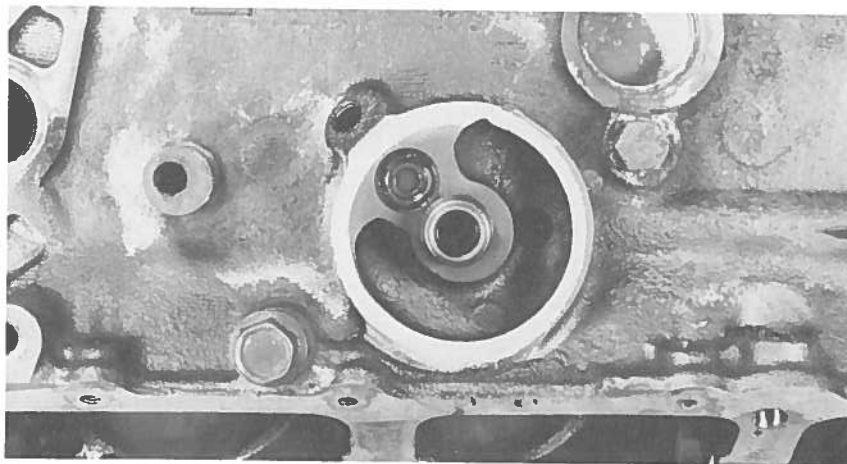
Camshaft bearings are driven out and installed with a long rod fitted with a plate that's slightly smaller than the outside diameter of the bearing and a hammer. The innermost bearings are installed first as this reduces the chances of damaging the outermost bearings. Careful attention must be paid to the orientation of the lubrication holes in the bearings. If these holes aren't aligned with the lube holes in the block, no oil will get to the camshaft journals, and the result will be almost-instantaneous disaster.

Camshaft bearing removal tools are almost impossible to rent and



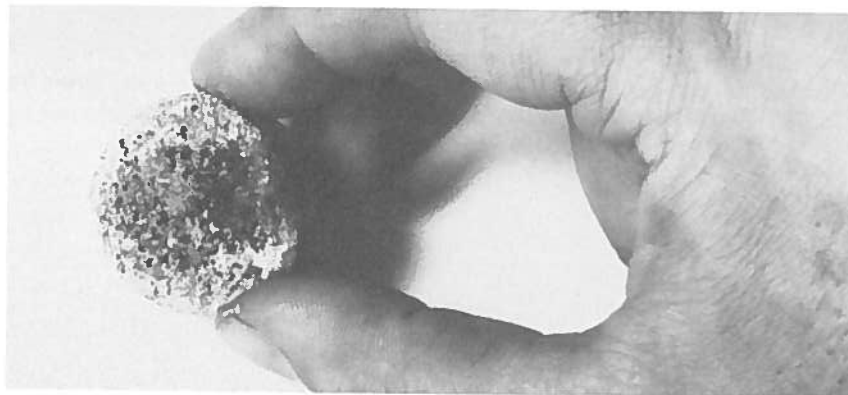
Three plugs are used on the top of the oil gallery. To remove them, you'll have to make a tool that fits each of them tightly. You can fabricate the tools by cutting off the threads of a bolt so that only the shank remains. For the smaller

plugs, you'll need a bolt with a 3/16in shank. For the larger plug, a bolt with a 5/16in shank is required. After grinding a square on the shanks, use a wrench on the bolt head to remove each plug.



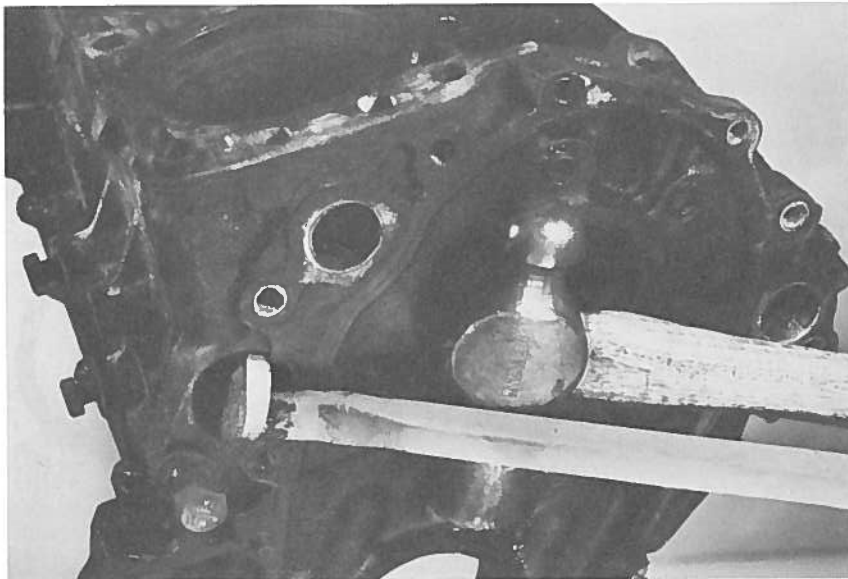
The bypass valve inside the oil filter boss on the block should be removed so that you can clean the block thoroughly. Remove the valve by sticking a

screwdriver through the valve and levering it out. Replacement valves are available from your local GM dealership and some engine rebuilders.



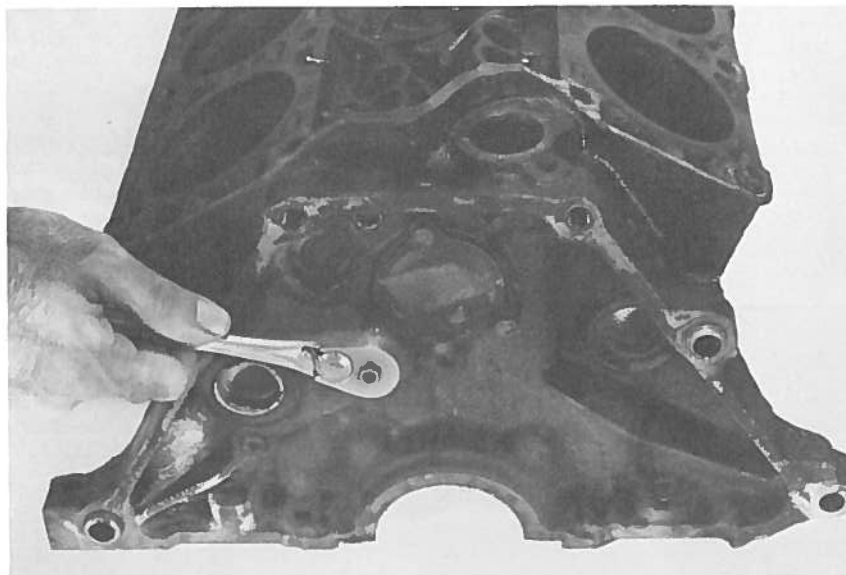
Even if the front of a core plug looks like it's in good condition, the side that faces the cooling jacket can be severely cor-

roded. Because of this, you need to replace the plugs when you rebuild the engine.



To remove the core plugs from the front and rear of the block, knock them into the block, using a hammer and socket,

then lever them out with a pry bar. In this photo, the head of a hammer is used as a fulcrum for levering the plug out.



Three bolts secure the camshaft plug to the rear of the block. Note the oil gallery

plug (with the square hole) below the handle of the ratchet.

quite expensive to buy. In many cases, the most cost-effective and least troublesome way to remove and replace camshaft bearings is to let your machine shop do the work for you.

Dipstick Tube

If the engine needs to be machined or hot-tanked, remove the dipstick tube so that it isn't damaged. Do this by rotating it back and forth while pulling it out. If you have trouble, find a bolt that just fits into the inside diameter of the tube and slip it in. Now you can clamp the outside of the tube where the bolt is located with a pair of visegrips and rotate and pull on the tube without fear of collapsing it. Alternately, you can tap it out from inside the block.



To remove the plugs from the side of the block, rip a slot in the center of the plug with a chisel. Then use the chisel to fold the side of the plug, relieving its death grip on the block. Be sure not to gouge the plug bore with the chisel. Insert a pry bar through the slot in the center of the plug, then lever the plug out.